SOIL SURVEY OF

Kiowa County, Oklahoma

United States Department of Agriculture
Soil Conservation Service
In cooperation with
Oklahoma Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1961–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service and the Oklahoma Agricultural Experiment Station. It is part of the technical assistance furnished to the Kiowa County Conservation District, Mountain View Conservation District, and North Fork of Red River Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Kiowa County are shown on the detailed soil map. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and shows the capability classification of each. It also shows the page where each soil is described and the range site, the pasture and hay group, and the tree and shrub group to which the soil has been assigned.

Individual colored maps that show the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, the range sites, and the tree and shrub groups.

Foresters and others can refer to the section "Use of the Soils for Trees and Shrubs," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

Ranchers and others can find, under "Range," groupings of the soils according to their suitability for range and, also, the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the sections "Engineering Uses of the Soils" and "Use of the Soils for Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Kiowa County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Climate."

Contents

Issued January 1979

Index to Mapping Units

Summary of Tables

SOIL SURVEY OF KIOWA COUNTY, OKLAHOMA

BY OTHO W. LAMAR, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE,
IN COOPERATION WITH OKLAHOMA AGRICULTURAL EXPERIMENT STATION

KIOWA COUNTY is in the southwestern part of Oklahoma (fig. 1). Hobart is the county seat. The county has a total area of 661,760 acres, or 1,034 square miles. Of this acreage, 4,544 acres is water. The county lies within the Central Rolling Red Plains physiographic region.

Farming is the chief enterprise in Kiowa County. Wheat, cotton, livestock, alfalfa for hay and seed, grain sorghum, and small grain are the leading farm products. Except for growing wheat, most farms are diversified. Some farms are used mainly for one crop and for raising livestock.

Livestock are raised in significant numbers in Kiowa County. Many of the farmers in the county depend on livestock for at least part of their income. Most farmers follow sound conservation practices in managing their farms. Fertilization is widely practiced to improve crop yield.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Kiowa County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes; the size and speed of streams; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

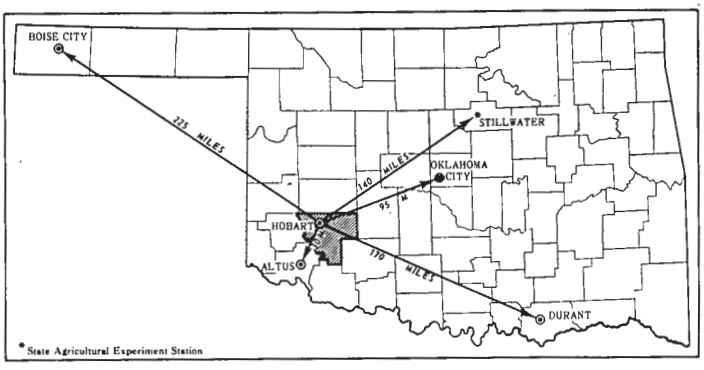


Figure 1.—Location of Kiowa County in Oklahoma.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Gotebo and Lawton, for example, are the names of two soil series. All the soils in the United States that have the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Carey silt loam, 1 to 3 percent slopes, is one of several phases within the Carey series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The detailed soil map was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series or of different phases within one series. Two such kinds of mapping units are shown on the soil map of Kiowa County: soil complexes and undifferentiated groups.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Albion-Shellabarger complex, 5 to 12 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils, joined by "and." Clairemont and Mangum soils is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Rock outcrop is a land type.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kind of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kind of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Kiowa County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map that shows soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Kiowa County are described in the following pages. Soil associations and delineations on the general soil map in this soil survey do not always agree fully with general soil maps of adjacent counties published at a different date. Differences are brought about by better knowledge of soils and modifications or refinements in soil series concepts. In addition, the uses of the general soil map have expanded in recent years, thus requiring a more precise and detailed map to accommodate the need. Still another difference is caused by the range in slope of the soils within an association.

1. Altus-Hardeman-Shellabarger association

Nearly level to strongly sloping, deep, well-drained soils that are loamy throughout; on uplands

This soil association makes up about 7 percent of the county. It is about 29 percent Altus soils, 25 percent Hardeman soils, 17 percent Shellabarger soils, and 29 percent the less extensive Albion, Devol, Dill, Grandfield, Lincoln, Meno, Tivoli, Pratt, and Yahola soils.

Altus soils are nearly level to very gently sloping and are on uplands. They are deep, well-drained, moderately permeable soils that are loamy throughout.

Hardeman soils are very gently sloping to sloping and are on uplands. They are deep, well-drained, moderately rapidly permeable soils that are loamy throughout.

Shellabarger soils are gently sloping to strongly sloping and are on uplands. They are deep, well-drained, moderately permeable soils that are loamy throughout.

The main concerns of management are controlling soil blowing and erosion, conserving moisture, and maintaining soil structure and fertility.

The soils in this association are used extensively for cultivated crops. Wheat, cotton, grain sorghum, and alfalfa are the main crops. A small part of the acreage is used for tame pasture and native grasses.

2. Hollister-Tillman-Lawton association

Nearly level to sloping, deep, well-drained loamy soils that have a loamy to clayey subsoil; on uplands

This soil association makes up about 52 percent of the county. It is about 33 percent Hollister soils, 26 percent Tillman soils, 14 percent Lawton soils, and 27 percent the less extensive Albion, Brico, Carey, Clairemont, Cyril, Foard, Grandfield, Hinkle, Lugert, Mangum, Miller, Port, Roscoe, St. Paul, Shellabarger, Tobosa, and Vernon soils, Natrustalfs, and Rock outcrop.

Hollister soils are nearly level or very gently sloping and are on uplands. They are deep, well-drained, slowly permeable soils. They have a loamy surface layer and a loamy or clayey subsoil.

Tillman soils are very gently sloping or gently sloping and are on uplands. They are deep, well-drained, slowly permeable soils. They have a loamy surface layer and a loamy or clayey subsoil.

Lawton soils are very gently sloping to sloping and are on uplands. They are deep, well-drained, moderately slowly permeable soils that are loamy throughout.

The main concerns of management are controlling erosion, conserving moisture, and maintaining soil structure and fertility.

The soils in this association are used extensively for cultivated crops. Wheat, cotton, and grain sorghum are the main crops. Small areas are used for tame pasture and native grasses.

3. St. Paul-Carey association

Nearly level to sloping, deep, well-drained soils that are loamy throughout; on uplands

This soil association makes up about 14 percent of the county. It is about 51 percent St. Paul soils, 34 percent Carey soils, and 15 percent the less extensive Clairemont, Gotebo, Hinkle, Hollister, Lugert, Port, and Tillman soils and Natrustalfs.

St. Paul soils are nearly level or very gently sloping and are on uplands. They are deep, well-drained, moderately slowly permeable soils that are loamy throughout.

Carey soils are very gently sloping to sloping and are on uplands. They are deep, well-drained, moderately permeable soils that are loamy throughout.

The main concerns of management are controlling erosion and maintaining or improving soil structure and fertility.

The soils in this association are used extensively for cultivated crops. Wheat, grain sorghum, and cotton are the main crops. Small areas are used for tame pasture and native grasses.

4. Rock outcrop-Brico-Talpa association

Very gently sloping to very steep Rock outcrop and very gently sloping to moderately steep, very shallow, shallow, or deep, well-drained loamy soils that have a loamy to clayey subsoil; on uplands

This soil association makes up about 7 percent of the county. It is about 46 percent Rock outcrop, 16 percent Brico soils, 13 percent Talpa soils, and 25 percent the less extensive Cyril, Dill, Gotebo, Lawton, Somervell, and Vernon soils.

Rock outcrop is nearly level to very steep and is on uplands. It consists of sandstone shale, anorthosite, granite, or limestone exposed at the surface and thinly mantled bedrock.

Brico soils are gently sloping to strongly sloping and are on uplands. They are deep, well-drained, moderately slowly permeable soils. They have a loamy surface layer and a loamy or clayey subsoil.

Talpa soils are very gently sloping to moderately sloping and are on uplands. They are very shallow or shallow, well-drained, moderately permeable soils. They are loamy throughout.

The main concerns of management are cobbles in the Brico soils, which hinder cultivation, and shallowness over bedrock and droughtiness in the Talpa soils. Other concerns of management are controlling erosion, slope, the complex pattern of soils and land type, and maintaining or improving soil structure and fertility.

The soils in this association are used mainly for range. Small areas are used for tame pasture.

5. Vernon association

Very gently sloping to strongly sloping, moderately deep, well-drained loamy to clayey soils that have a clayey subsoil; on uplands

This soil association makes up about 5 percent of the county. It is about 84 percent Vernon soils and 16 percent the less extensive Cyril, Gotebo, Lawton, Mangum, and Tillman soils and Rock outcrop.

Vernon soils are very gently sloping to strongly sloping and are on uplands. They are moderately deep, well-drained, very slowly permeable soils. They have a loamy or clayey surface layer and a clayey subsoil.

The main concerns of management are maintaining or improving soil structure and fertility, controlling erosion, the irregular slopes, and the complex pattern of occurrence with other soils.

The soils in this association are used mainly for range. Small areas are used for wheat or grain sorghum.

6. Port-Lugert-Clairemont association

Nearly level, deep, well-drained soils that are loamy throughout; on flood plains

This soil association makes up about 12 percent of the county. It is about 26 percent Port soils, 22 percent Lugert soils, 15 percent Clairemont soils, and 37 percent the less extensive Cyril, Lincoln, Miller, McLain, Mangum, Reinach, and Port soils.

Port, Lugert, and Clairemont soils are nearly level and are on flood plains. They are deep, well-drained, moderately permeable soils that are loamy throughout.

The main concerns of management are flooding, maintaining or improving soil structure and fertility, and controlling erosion.

The soils in this association are used mainly for cultivated crops. Wheat, grain sorghum, cotton, and alfalfa are the main crops.

7. Miller association

Nearly level, deep, moderately well drained soils that are loamy or clayey throughout; on flood plains

This soil association makes up about 3 percent of the county. It is about 77 percent Miller soils and 23 per-

cent the less extensive Clairemont, Lugert, Mangum, McLain, and Yahola soils.

Miller soils are nearly level and are on flood plains. They are deep, moderately well drained, very slowly permeable soils that are loamy or clayey throughout.

The main concerns of management are flooding, maintaining or improving soil structure, controlling erosion, salinity, channeling, and the irregular shape of the areas.

The soils in this association are used mainly for cultivated crops. Wheat, grain sorghum, and cotton are the main crops. Small areas are used for native grasses and tame pasture.

Descriptions of the Soils

In this section the soils of Kiowa County are described and their use and management are discussed. Each soil series is described in detail and then, briefly, the mapping units in that series. Unless specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the soil series is representative of mapping units in that series. If a given mapping unit has a profile in some way different from the one described in the series, these differences are stated in the description of the mapping unit, or they are apparent from the name of the mapping unit. The description of each mapping unit contains suggestions on how the soil can be managed.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Rock outcrop, for example, does not belong to a soil series but, nevertheless, is listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol that identifies the mapping unit on the detailed soil map. Listed at the end of the description of a mapping unit are the capability unit, range site, pasture and hay group, and tree and shrub group to which the mapping unit has been assigned. An explanation of the capability classification system is in the section "Capability Grouping." A description of the pasture and hay groups is in the section "Management of the Soils for Pasture and Hay." The page for the description of other interpretative groups can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The main concerns of management are explained in the mapping unit description for most soils. If management is not explained for the soil in the description of the mapping unit, it is described for specified uses in the section "Use and Management of the Soils."

The acreage and extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).[1]

Albion Series

The Albion series consists of moderately deep, well-drained or somewhat excessively drained, sloping to strongly sloping soils on uplands. These soils formed in sandy and gravelly old alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is brown gravelly sandy loam 12 inches thick. The upper 24 inches of the subsoil is reddish-brown gravelly sandy loam, and the lower 14 inches is yellowish-red gravelly loamy sand. The underlying material is yellowish-red gravelly sand to a depth of 65 inches.

Permeability is moderately rapid. The available water capacity is medium.

Representative profile of Albion gravelly sandy loam in an area of Albion-Shellabarger complex, 5 to 12 percent slopes, 1,600 feet west and 1,700 feet south of the northeast corner of sec. 8, T. 6 N., R. 21 E.:

A1—0 to 12 inches, brown (7.5YR 4/2) gravelly sandy loam, dark brown (7.5YR 3/2) moist; moderate, fine, granular structure; slightly hard, very friable; about 15 percent, by volume, pebbles more than 2 millimeters in diameter; slightly acid; clear, smooth boundary.

B2t—12 to 36 inches, reddish-brown (5YR 4/4) gravelly sandy loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; slightly hard, friable; about 20 percent, by volume, pebbles more than 2 millimeters in diameter; nearly continuous clay films on faces of peds; neutral; gradual, smooth boundary.

B3—36 to 50 inches, yellowish-red (5YR 5/6) gravelly loamy sand, yellowish red (5YR 4/6) moist; weak, granular structure; loose; about 20 percent, by volume, pebbles more than 2 millimeters in diameter; few films and threads of calcium carbonate in the lower part; calcareous; moderately alkaline; gradual, smooth boundary.

IIC—50 to 65 inches, yellowish-red (5YR 5/6) gravelly sand, yellowish red (5YR 4/6) moist; single grained; loose; about 40 percent, by volume, pebbles more than 2 millimeters in diameter; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. Threads or films of calcium carbonate are below a depth of 40 inches. Pebbles more than 2 millimeters in diameter make up 10 to 20 percent, by volume, of the A horizon; 15 to 30 percent of the B2t horizon; and 20 to 40 percent of the B3 and IIC horizons.

The A horizon is brown or dark brown. Reaction is slightly acid or medium acid.

The B2t horizon is reddish-brown, yellowish-red, or red gravelly loam or gravelly sandy loam. Reaction is slightly acid to moderately alkaline. The B3 horizon is red or yellowish-red gravelly sandy loam or gravelly loamy sand. Reaction is slightly acid to moderately alkaline.

The IIC horizon is sand or gravelly sand. Reaction is slightly acid to moderately alkaline.

[1] Italic numbers in parentheses refer to Literature Cited, page 70.

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Albion-Shellabarger complex, 5 to 12 percent slopes	2,100	0.3	Lawton-Rock outcrop complex, 1 to 12 percent slopes	9,050	1.4
Altus fine sandy loam, 0 to 1 percent slopes	8,400	1.3	Lincoln loamy fine sand	2,000	.3
Altus fine sandy loam, 1 to 3 percent slopes	5,000	.7	Lincoln soils	5,000	.8
Brico cobbly loam, 3 to 12 percent slopes	5,250	.8	Lugert loam	20,400	3.1
Carey silt loam, 1 to 3 percent slopes	8,500	1.3	McLain silty clay loam	2,300	.3
Carey silt loam, 3 to 5 percent slopes	7,350	1.1	Meno loamy fine sand, 0 to 3 percent slopes	1,150	.2
Carey silt loam, 2 to 5 percent slopes, eroded	10,550	1.6	Miller clay	14,000	2.1
Carey-Hinkle complex, 1 to 5 percent slopes	3,320	.5	Miller soils, saline	10,700	1.6
Carey soils, 2 to 8 percent slopes, severely eroded	1,850	.3	Natrustalfs	1,000	.1
Clairemont and Mangum soils	20,400	3.1	Port silty clay loam	26,900	4.1
Cobb fine sandy loam, 1 to 3 percent slopes	1,200	.2	Reinach loam	1,200	.2
Cyril loam	5,000	.7	Rock outcrop	2,700	.4
Devol loamy fine sand, 0 to 3 percent slopes	3,130	.5	Rock outcrop-Brico complex, 8 to 50 percent slopes	23,450	3.6
Dill-Rock outcrop complex, 3 to 12 percent slopes	1,000	.2	Roscoe clay	2,000	.3
Foard silt loam, 0 to 1 percent slopes	25,500	3.8	St. Paul silt loam, 0 to 1 percent slopes	24,250	3.7
Gotebo loam, 5 to 12 percent slopes	2,000	.3	St. Paul silt loam, 1 to 3 percent slopes	24,400	3.7
Gotebo-Rock outcrop complex, 3 to 20 percent slopes	3,900	.6	St. Paul-Hinkle complex, 0 to 1 percent slopes	2,850	.4
Grandfield loamy fine sand, 0 to 3 percent slopes	2,800	.4	Shellabarger fine sandy loam, 3 to 5 percent slopes	7,350	1.1
Grandfield fine sandy loam, 1 to 3 percent slopes	1,500	.2	Somervell cobbly loam, 3 to 20 percent slopes	1,800	.3
Hardeman fine sandy loam, 1 to 3 percent slopes	1,000	.1	Talpa loam, 1 to 5 percent slopes	1,000	.2
Hardeman fine sandy loam, 3 to 5 percent slopes	5,000	.7	Talpa-Rock outcrop complex, 8 to 50 percent slopes	8,300	1.3
Hardeman fine sandy loam, 5 to 8 percent slopes	5,800	.9	Tillman clay loam, 1 to 3 percent slopes	64,421	9.7
Hollister silty clay loam, 0 to 1 percent slopes	101,000	15.3	Tillman clay loam, 3 to 5 percent slopes	7,200	1.1
Hollister silty clay loam, 1 to 3 percent slopes	7,100	1.1	Tillman-Hinkle complex, 1 to 3 percent slopes	24,250	3.7
Hollister silty clay loam, 1 to 3 percent slopes, eroded	6,300	.9	Tillman-Vernon complex, 2 to 5 percent slopes, eroded	9,850	1.5
Indiahoma silty clay loam, 1 to 3 percent slopes	2,100	.3	Tivoli-Pratt complex, 3 to 15 percent slopes	2,900	.4
Indiahoma silty clay loam, 3 to 5 percent slopes	1,800	.3	Tobosa clay, 0 to 1 percent slopes	3,450	.5
Lawton loam, 1 to 3 percent slopes	21,450	3.2	Vernon clay loam, 2 to 5 percent slopes	31,900	4.8
Lawton loam, 3 to 5 percent slopes	11,750	1.7	Vernon-Mangum complex, 0 to 12 percent slopes	4,400	.7
Lawton loam, 2 to 5 percent slopes, eroded	5,370	.8	Vernon-Rock outcrop complex, 2 to 12 percent slopes	1,875	.3
Lawton loam, 5 to 8 percent slopes	2,650	.4	Vernon soils, 5 to 12 percent slopes	23,100	3.5
			Yahola fine sandy loam	2,000	.3
			Water	4,544	.7
			Total	661,760	100.0

AsE—Albion-Shellabarger complex, 5 to 12 percent slopes. This complex consists of sloping to strongly sloping soils on uplands. It is about 75 percent Albion gravelly sandy loam and 25 percent Shellabarger fine sandy loam. The two soils are so intermingled that it is not practical to map them separately. Included in mapping are spots of Lawton soils and soils that are similar to this Albion soil but have a surface layer that is lighter colored or less than 10 inches thick.

These soils are used for range. Capability unit VIe–7; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 7.

Altus Series

The Altus series consists of deep, well-drained, nearly level or very gently sloping soils on uplands. These soils formed in calcareous loamy and sandy old alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is dark-brown fine sandy loam about 10 inches thick. The upper 7 inches of the subsoil is dark-brown fine sandy loam, the middle 27 inches is dark-brown sandy clay loam, and the lower 21 inches is brown or pale-brown sandy clay loam.

Permeability is moderate. The available water capacity is medium.

Representative profile of Altus fine sandy loam, 0 to 1 percent slopes, 100 feet south and 200 feet west of the northeast corner of sec. 9, T. 6 N., R. 20 W.:

Ap—0 to 10 inches, dark-brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; neutral; abrupt, smooth boundary.

B1—10 to 17 inches, dark-brown (7.5YR 4/2) fine sandy loam, dark brown (7.5YR 3/2) moist; strong, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B21t—17 to 32 inches, dark-brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, blocky structure; slightly hard, firm; mildly alkaline; clear, smooth boundary.

B22t—32 to 44 inches, dark-brown (7.5YR 4/3) sandy clay loam, dark brown (7.5YR 3/2) moist; strong, medium,

blocky structure; hard, firm; nearly continuous clay films on faces of peds; mildly alkaline; gradual, smooth boundary.

B31—44 to 58 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate, fine, subangular blocky structure; hard, firm; few brown and black concretions; few bodies of soft lime; moderately alkaline; gradual, smooth boundary.

B32—58 to 65 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; weak, fine, subangular blocky structure; slightly hard, firm; calcareous; moderately alkaline.

Depth to soft lime ranges from 27 inches to more than 60 inches. In some areas a buried A horizon is between the depths of 40 and 60 inches.

The A horizon is dark brown or dark grayish brown. Reaction is slightly acid or neutral.

The B2t horizon is dark-brown, very dark grayish-brown, reddish-brown, or yellowish-red fine sandy loam to sandy clay loam. Reaction is neutral to moderately alkaline. The B3 horizon is brown, pale-brown, reddish-brown, or reddish-yellow fine sandy loam to sandy clay loam. Reaction is neutral to moderately alkaline.

AtA—Altus fine sandy loam, 0 to 1 percent slopes. This nearly level soil has the profile described as representative of the series. Included in mapping, and making up about 10 percent each of the acreage, are areas of Hardeman soils, areas of soils that are similar to this Altus soil but have a less clayey subsoil, and areas of soils that are similar to this Altus soil but have a dark-brown or dark grayish-brown surface layer less than 10 inches thick.

The main concerns of management are controlling soil blowing and erosion and maintaining soil structure and fertility. Some important management practices are stubble mulching, using crop residue and adding plant nutrients as needed, growing cover crops, keeping tillage to a minimum and tilling at variable depth, and tilling on the contour.

This soil is used for wheat, grain sorghum, cotton, alfalfa, and tame pasture. Capability unit IIe–2; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

AtB—Altus fine sandy loam, 1 to 3 percent slopes. This is a very gently sloping soil. Included in mapping are about 15 percent areas of Hardeman soils. Also included are about 5 percent areas of soils that are similar to this Altus soil but have a dark-brown or dark grayish-brown surface layer less than 10 inches thick.

The main concerns of management are controlling soil blowing and erosion and maintaining soil fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depth, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–3; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

Brico Series

The Brico series consists of deep, well-drained, gently sloping to strongly sloping soils on uplands. These soils formed in material weathered from granite under a cover of native grasses.

In a representative profile the surface layer is brown cobbly loam about 11 inches thick. The upper 13 inches of the subsoil is reddish-brown cobbly clay, and the lower 48 inches is red cobbly clay loam.

Permeability is moderately slow. The available water capacity is low.

Representative profile of Brico cobbly loam, 3 to 12 percent slopes, 600 feet south and 50 feet east of the northwest corner of sec. 11, T. 3 N., R. 16 W.:

A11—0 to 5 inches, brown (7.5YR 5/2) cobbly loam, dark brown (7.5YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; about 10 percent, by volume, granitic pebbles 2 millimeters to 3 inches in diameter; 20 percent cobbles; slightly acid; clear, smooth boundary.

A12—5 to 11 inches, brown (7.5YR 4/2) cobbly loam, dark brown (7.5YR 3/2) moist; strong, fine, granular structure; slightly hard, friable; common pores and worm casts; about 15 percent, by volume, granitic pebbles 2 millimeters to 3 inches in diameter; 20 percent cobbles; slightly acid; clear, smooth boundary.

B21t—11 to 24 inches, reddish-brown (5YR 4/4) cobbly clay, dark reddish brown (5YR 3/4) moist; strong, medium, blocky structure; very hard, very firm; 20 percent, by volume, granitic pebbles 2 millimeters to 3 inches in diameter; 30 percent cobbles; dark reddish-brown (5YR 3/3) patchy clay films on faces of peds; shiny surfaces on faces of peds; neutral; gradual, smooth boundary.

B22t—24 to 40 inches, red (2.5YR 4/6) cobbly clay loam, dark red (2.5YR 3/6) moist; strong, fine and medium, blocky structure; very hard, very firm; about 20 percent, by volume, granitic pebbles 2 millimeters to 3 inches in diameter; 30 percent cobbles; patchy clay films on faces of peds; neutral; gradual, smooth boundary.

B3—40 to 72 inches, red (2.5YR 5/6) cobbly clay loam, red (2.5YR 4/6) moist; weak, fine, subangular blocky structure; very hard, very firm; weakly cemented; about 30 percent, by volume, granitic pebbles 2 millimeters to 3 inches in diameter; 40 percent cobbles; neutral.

The solum ranges from 40 inches to more than 60 inches in thickness. Reaction is slightly acid or neutral throughout.

The A horizon is dark brown, brown, dark reddish brown, dark reddish gray, reddish brown, or reddish gray. The A12 horizon is loam, gravelly loam, or cobbly loam. The A horizon is 2 to 20 percent, by volume, granitic cobbles more than 3 inches in diameter and 10 to 25 percent, by volume, pebbles less than 3 inches in diameter.

The B2t horizon is brown, dark-brown, strong-brown, light-brown, reddish-yellow, reddish-brown, yellowish-red, light reddish-brown, red, or light-red cobbly clay loam, cobbly clay, or very cobbly clay. It is 5 to 30 percent, by volume, granitic cobbles more than 3 inches in diameter and 20 to 50 percent granitic pebbles less than 3 inches in diameter. The B3 horizon is similar to the B2t horizon in color. It is cobbly clay loam or very cobbly clay loam that is 10 to 50 percent, by volume, granitic cobbles more than 3 inches in diameter and 30 to 50 percent granitic pebbles less than 3 inches in diameter.

BrE—Brico cobbly loam, 3 to 12 percent slopes. This gently sloping to strongly sloping soil is on uplands (fig. 2). Included in mapping, and making up about 5 percent each of the acreage, are areas of Hollister and Lawton soils.

This soil is used for range. Capability unit VIIs–2; Boulder Ridge range site; pasture and hay group not assigned; tree and shrub group 9.

Figure 2.—An area of Brico cobbly loam, 3 to 12 percent slopes, in the foreground that shows granitic cobbles on the surface. Outcrops of granite are in the background.

Carey Series

The Carey series consists of deep, well-drained, very gently sloping to sloping soils on uplands. These soils formed in silty sediment under a cover of native grasses.

In a representative profile the surface layer is dark-brown silt loam about 14 inches thick. The upper 23 inches of the subsoil is reddish-brown silty clay loam, the middle 11 inches is red silty clay loam, and the lower 17 inches is red loam.

Permeability is moderate. The available water capacity is high.

Representative profile of Carey silt loam, 1 to 3 percent slopes, 600 feet east and 350 feet north of the southwest corner of sec. 15, T. 3 N., R. 18 W.:

Ap—0 to 6 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

A1—6 to 14 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B21t—14 to 25 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; hard, firm; organic stains on faces of peds; nearly continuous clay films on faces of peds; moderately alkaline; gradual, smooth boundary.

B22t—25 to 37 inches. reddish-brown (2.5YR 5/4) silty clay loam, reddish brown (2.5YR 4/4) moist; strong, medium, subangular blocky structure; hard, firm, nearly continuous clay films on faces of peds; common soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B28tca—37 to 48 inches, red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, firm; common soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B3—48 to 65 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; weak, medium, subangular blocky structure; hard, firm; calcareous; moderately alkaline.

The solum ranges from 40 inches to more than 70 inches in thickness. Depth to secondary carbonates ranges from 15 to 30 inches.

The A horizon is dark grayish-brown, dark-brown, brown, dark reddish-brown, or reddish-brown loam or silt loam. Reaction is neutral or mildly alkaline.

The B2t horizon is reddish-brown, yellowish-red, or red silt loam, clay loam, or silty clay loam. Reaction is neutral to moderately alkaline. The B2tca horizon is reddish-brown, yellowish-red, light yellowish-brown, reddish-yellow, red, light reddish-brown, light-red, or red silt loam, clay loam, or silty clay loam. The B3 horizon is red or yellowish-red loam or silt loam.

CaB—Carey silt loam, 1 to 3 percent slopes. This very gently sloping soil has the profile described as representative of the series. Included in mapping are areas

of St. Paul and Tillman soils, which make up about 5 percent each of the acreage.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are stubble mulching, tilling on the contour, using crop residue and adding plant nutrients as needed, growing cover crops, keeping tillage to a minimum and tilling at variable depths, and installing terraces that have protected outlets.

This soil is used mainly for wheat, grain sorghum, and cotton. The native vegetation is mid and tall grasses. Capability unit IIe–1; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

CaC—Carey silt loam, 3 to 5 percent slopes. This is a gently sloping soil. Included in mapping, and making up about 5 percent of the acreage, are areas of Gotebo soils.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are returning all crop residue to the soil, adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used mainly for wheat, grain sorghum, and cotton. The native vegetation is mid and tall grasses. Capability unit IIIe–2; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

CaC2—Carey silt loam, 2 to 5 percent slopes, eroded. This is a very gently sloping or gently sloping, eroded soil. It has a profile similar to the one described as representative of the series, but the subsoil is exposed over about 25 percent of the acreage and the remaining plow layer is a mixture of material from the surface layer and subsoil. Small rills and gullies are common in most areas. Included in mapping are areas of Gotebo soils, which make up about 15 percent of the acreage.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are returning all crop residue to the soil, adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, installing terraces that have protected outlets, and planting high-residue, soil-maintaining crops.

This soil is used mainly for wheat, grain sorghum, and cotton. Some areas are used for tame pasture. Capability unit IVe–4; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

CbD—Carey-Hinkle complex, 1 to 5 percent slopes. This complex consists of very gently sloping to gently sloping soils on uplands. It is about 70 percent Carey silt loam and 20 percent Hinkle silt loam. The two soils are so intermingled that it is not practical to map them separately. The Carey soil in this complex has a profile similar to the one described as representative of the Carey series, but the surface layer is only about 8 inches thick. Included in mapping are areas of Natrustalfs and Gotebo soils, which make up about 5 percent each of the acreage.

The main concerns of management are maintaining soil structure, reducing surface crusting, increasing the water intake rate, and reducing the effects of sodium. Concentrations of sodium in the subsoil of the Hinkle soils reduce the intake rate, cause surface crusting, and damage soil structure. These effects make the soil droughty and retard the emergence of seedlings. Some important management practices are returning all crop residue to the soil, adding plant nutrients as needed, stubble mulching, and keeping tillage to a minimum and tilling at a shallow depth to reduce the hazard of bringing salts to the surface. Mulching reduces crusting. Chemical amendments, such as gypsum, also are beneficial in places.

These soils are used mainly for wheat, grain sorghum, and cotton. Some areas are used for tame pasture. Both parts in capability unit IVs–1; Carey part in Loamy Prairie range site, Hinkle part in Slickspot range site; Carey part in pasture and hay group 8A, Hinkle part in pasture and hay group 8D; both parts in tree and shrub group 5.

CeD3—Carey soils, 2 to 8 percent slopes, severely eroded. This mapping unit consists of very gently sloping to sloping, severely eroded soils on uplands. These soils have a profile similar to the one described as representative of the Carey series, but the surface layer is silt loam or silty clay loam and has been thinned and mixed with the subsoil in most of the area. Also, in about 25 percent of the area the silty clay loam subsoil is exposed. Gullies are common. They are 2 to 8 feet deep, 5 to 15 feet wide, and 50 to 200 feet apart. Included in mapping are about 15 percent areas of Lawton soils and 10 percent areas of Gotebo soils.

These soils are used mainly for range. They are not suited to crops. Capability unit VIe–1; Eroded Prairie range site; pasture and hay group 8F; tree and shrub group 9.

Clairemont Series

The Clairemont series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is reddish-brown silt loam about 6 inches thick. The upper 22 inches of the underlying material is reddish-brown silt loam. The lower part is reddish-brown silty clay loam to a depth of 75 inches.

Permeability is moderate. The available water capacity is high.

Representative profile of Clairemont silt loam in an area of Clairemont and Mangum soils, 1,000 feet south and 200 feet west of the northeast corner of sec. 7, T. 6 N., R. 17 W.:

A1—0 to 6 inches, reddish-brown (5YR 5/4) silt loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; slightly hard, friable; moderately alkaline; clear, smooth boundary.

C1—6 to 28 inches, reddish-brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable; few strata of various textures; calcareous; moderately alkaline; clear, smooth boundary.

C2—28 to 55 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; massive; hard, firm; weak bedding planes; calcareous; moderately alkaline; gradual, smooth boundary.

C3—55 to 75 inches, reddish-brown (2.5YR 5/4) silty clay loam, reddish brown (2.5YR 4/4) moist; massive; hard,

firm; weak bedding planes; calcareous; moderately alkaline.

The soil is reddish-brown or brown silt loam or silty clay loam throughout. In places the A horizon is calcareous. The upper 40 inches of the C horizon is 18 to 35 percent clay that has thin strata of various textures.

Cm—Clairemont and Mangum soils. This mapping unit consists of nearly level soils on flood plains. It is about 75 percent Clairemont soils and 20 percent Mangum soils. The two soils occur together without regularity of pattern (fig. 3). One of the Clairemont soils in this complex has the profile described as representative of the Clairemont series. The other Clairemont soil has a profile similar to that described as representative of the Clairemont series, but the surface layer is silty clay loam. One of the Mangum soils in this complex has the profile described as representative of the Mangum series. The other Mangum soil has a profile similar to that described as representative of the Mangum series, but the surface layer is clay. Slopes are 0 to 1 percent. These soils are frequently flooded. Included in mapping are about 3 percent areas of Miller soils and 2 percent areas of Port soils.

These soils are used mainly for native range. Small areas are used for improved bermudagrass pasture. Both parts in capability unit Vw–2; Clairemont part in Loamy Bottomland range site, Mangum part in Heavy Bottomland range site; Clairemont part in pasture and hay group 2A, Mangum part in pasture and hay group 1A; both parts in tree and shrub group 2.

Cobb Series

The Cobb series consists of moderately deep, well-drained, very gently sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of native grasses.

In a representative profile the surface layer is reddish-brown fine sandy loam about 12 inches thick. The subsoil is reddish-brown or red sandy clay loam. Weakly cemented sandstone is at a depth of about 32 inches.

Figure 3.—An area of Clairemont and Mangum soils. Right of the drainageway mainly is Clairemont soils and left is mainly Mangum soils.

Permeability is moderate. The available water capacity is high.

Representative profile of Cobb fine sandy loam, 1 to 3 percent slopes, 1,100 feet west and 600 feet south of the northeast corner of sec. 13, T. 7 N., R. 14 W.:

Ap—0 to 7 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

A1—7 to 12 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

B21t—12 to 26 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, subangular blocky; slightly hard, friable; neutral; gradual, smooth boundary.

B22t—26 to 32 inches, red (2.5YR 56/) sandy clay loam, red (2.5YR 4/6) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable; mildly alkaline; clear, smooth boundary.

R—32 to 60 inches, weakly cemented reddish sandstone that has thin coatings of calcium carbonate in crevices.

Depth to weakly cemented to strongly cemented sandstone bedrock ranges from 20 to 40 inches. The A horizon is slightly acid or neutral. The Bt horizon is reddish brown or red. The B21t horizon is slightly acid or neutral. The B22t horizon is neutral to moderately alkaline.

CoB—Cobb fine sandy loam, 1 to 3 percent slopes. This is a very gently sloping soil. Included in mapping are about 15 percent areas of Grandfield soils. Also included are about 20 percent areas of soils that are similar to this Cobb soil but are more than 40 inches deep over sandstone and about 10 percent areas of soils that are similar to this Cobb soil but have a more clayey subsoil.

The main concerns of management are controlling soil blowing and water erosion and maintaining soil fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, and cotton. Small areas are used for tame pasture and native grasses. Capability unit IIIe–3; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

Cyril Series

The Cyril series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy sediment under a cover of hardwood forest and an understory of native grasses.

In a representative profile the surface layer is dark grayish-brown loam about 21 inches thick. The subsoil is brown loam about 21 inches thick. The underlying material is brown fine sandy loam to a depth of 60 inches.

Permeability is moderate. The available water capacity is high.

Representative profile of Cyril loam, 1,300 feet south and 400 feet west of the northeast corner of sec. 24, T. 4 N., R. 19 W.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

A1—8 to 21 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2); moist; moderate, medium, granular structure; slightly hard, friable; calcareous; moderately alkaline; gradual, smooth boundary.

B2—21 to 42 inches, brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; slightly hard, friable; few films and soft bodies of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C—42 to 60 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; massive; slightly hard, friable; common films and soft bodies of calcium carbonate; calcareous; moderately alkaline.

The A horizon is very dark grayish brown, dark grayish brown, or grayish brown and is 20 to 30 inches thick. The Ap horizon ranges from noncalcareous to calcareous.

The B2 horizon is brown or reddish-brown loam or fine sandy loam. It is 1 to 5 percent visible calcium carbonate in the form of films or soft bodies.

The C horizon is brown, light-brown, or reddish-yellow loam or fine sandy loam. It is 2 to 8 percent visible calcium carbonate in the form of films or soft bodies.

Cy—Cyril loam. This nearly level soil is subject to occasional flooding. Slopes are 0 to 1 percent. Included in mapping, and making up about 10 percent each of the acreage, are areas of Lugert and Yahola soils.

The main concerns of management are maintaining soil structure and fertility and protecting the soil from flooding. Flooding can be reduced by watershed protection projects and detention dams. Another important management practice is growing cover crops along with low-residue crops.

The soil is used for wheat, grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture and native grasses. Most crops grown on this soil produce a large amount of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIw–2; Loamy Bottomland range site; pasture and hay group 2A; tree and shrub group 3.

Devol Series

The Devol series consists of deep, well-drained, nearly level or very gently sloping soils on uplands. These soils formed in sandy or loamy alluvial or eolian sediment under a cover of native grasses.

In a representative profile the surface layer is brown loamy fine sand about 14 inches thick. The upper 22 inches of the subsoil is reddish-brown fine sandy loam, and the lower 24 inches is yellowish-red fine sandy loam. The underlying material is yellowish-red loamy fine sand to a depth of 72 inches.

Permeability is moderately rapid. The available water capacity is medium.

Representative profile of Devol loamy fine sand, 0 to 3 percent slopes, 800 feet west and 600 feet north of the southwest corner of the SE¼ sec. 12, T. 3 N., R. 19 W.:

A1—0 to 14 inches, brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak, fine, granular structure; soft, very friable; neutral, clear, smooth boundary.

B2t—14 to 36 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, medium, prismatic structure parting to weak, medium, granular; slightly hard, friable; clay bridging sand grains; mildly alkaline; gradual, smooth boundary.

B3—36 to 60 inches, yellowish-red (5YR 4/6) fine sandy loam, yellowish red (5YR 4/6) moist; weak, coarse, prismatic structure parting to weak, medium, granular; slightly hard, friable; mildly alkaline; gradual, smooth boundary.

C—60 to 72 inches, yellowish-red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; massive; soft, very friable; moderately alkaline.

The A horizon is reddish brown or brown. The B2t horizon is reddish brown or red. The B3 horizon is yellowish-red or red fine sandy loam or loamy fine sand. The C horizon is the same colors as the B3 horizon.

DeB—Devol loamy fine sand, 0 to 3 percent slopes. This is a nearly level and very gently sloping soil. Included in mapping, and making up about 10 percent each of the acreage, are areas of Hardeman and Grandfield soils. Also included are about 20 percent areas of soils that have slopes of 3 to 8 percent.

The main concerns of management are controlling soil blowing and water erosion and maintaining fertility. Returning large amounts of residue to the soil and adding plant nutrients help to maintain fertility and control soil blowing. Delaying tillage in spring during the period of critical soil blowing also helps to control soil blowing. Where row crops are grown, the rows should be planted perpendicular to the direction of the prevailing wind to reduce soil blowing. Other important management practices are stubble mulching, growing cover crops, and keeping tillage to a minimum and tilling at variable depths.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–6; Deep Sand range site; pasture and hay group 9A; tree and shrub group 7.

Dill Series

The Dill series consists of moderately deep, well-drained, gently sloping to strongly sloping soils on uplands. These soils formed in material weathered from sandstone under a cover of native grasses.

In a representative profile the surface layer is reddish-brown fine sandy loam about 12 inches thick. The subsoil is red fine sandy loam. Weakly cemented sandstone is at a depth of about 30 inches.

Permeability is moderately rapid. The available water capacity is low.

Representative profile of Dill fine sandy loam in an area Dill-Rock outcrop complex, 3 to 12 percent slopes, 400 feet west and 700 feet south of northeast corner of the SW¼ sec. 12, T. 7 N., R. 14 W.:

A1—0 to 12 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, medium, granular structure; loose, very friable; neutral; gradual, smooth boundary.

B2—12 to 30 inches, red (2.5YR 5/6) fine sandy loam, red (2.5YR 4/6) moist; weak, medium, subangular blocky structure; slightly hard, very friable; few fragments of sandstone in lower 6 inches; neutral; abrupt, wavy boundary.

C—30 to 42 inches, red (2.5YR 5/6), soft, fine-grained sandstone, red (2.5YR 4/6) moist; massive; neutral.

The solum ranges from 20 to 40 inches in thickness. The B and C horizons are reddish brown or red. The C horizon is weakly cemented sandstone. In places the crevices in the sandstone are coated with calcium carbonate.

DrE—Dill-Rock outcrop complex, 3 to 12 percent slopes. This complex consists of gently sloping to strongly sloping soils on uplands. It is about 60 percent Dill fine sandy loam, 20 percent Rock outcrop, and 20 percent soils that are similar to this Dill soil but are less than 20 inches deep over bedrock. The Dill soil and Rock outcrop are so intermingled that it is impractical to map them separately. The Rock outcrop part of this complex is a land type that consists of bare sandstone bedrock or bedrock mantled with less than 3 inches of soil material.

These soils are used for range. Both parts in capability unit VIe–3; Dill part in Sandy Prairie range site, Rock outcrop part not assigned to a range site; Dill part in pasture and hay group 8A, Rock outcrop part not assigned to a pasture and hay group; both parts in tree and shrub group 9.

Foard Series

The Foard series consists of deep, moderately well drained, nearly level soils on uplands. These soils formed in old alluvial loamy sediment under a cover of native grasses.

In a representative profile the surface layer is brown silt loam about 6 inches thick. The upper 40 inches of the subsoil is brown silty clay loam, and the lower 19 inches is reddish-yellow silty clay loam.

Permeability is very slow. The available water capacity is medium.

Representative profile of Foard silt loam, 0 to 1 percent slopes, 400 feet south and 200 feet east of the northwest corner of the SW¼ sec. 21, T. 7 N., R. 16 W.:

Ap—0 to 6 inches, brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, firm; upper 1 inch is a vesicular crest; neutral; abrupt, smooth boundary.

B21t—6 to 17 inches, brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, block structure; very hard, very firm; coatings of silt loam between peds; mildly alkaline; clear, smooth boundary.

B22t—17 to 46 inches, brown (7.5YR 5/2) silty clay loam, brown (7.5YR 4/2) moist; moderate, medium, blocky structure; very hard, very firm, many salt seams below a depth of 34 inches; many fine concretions of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B3—46 to 65 inches, reddish-yellow (5YR 6/6) silty clay loam, yellowish red (5YR 5/6) moist; many grayish-brown (10YR 5/2) streaks and spots; weak, coarse, blocky structure; very hard, very firm; many fine concretions; calcareous; moderately alkaline.

The solum ranges from 55 to 70 inches in thickness. Depth to lime ranges from 15 to 25 inches.

The Ap horizon is dark grayish brown, brown, or dark brown. Reaction is neutral to mildly alkaline.

The B21t horizon is dark grayish-brown, brown, or dark-brown silty clay loam, silty clay, or clay. Reaction is mildly alkaline or moderately alkaline. The B22t horizon is brown or dark-brown silty clay loam or silty clay. Reaction is mildly alkaline or moderately alkaline. The B2t horizon is 15 to 25 percent exchangeable sodium, and electrical conductivity of the saturated extract is 2 to 6 millimhos per centimeter. The B3 horizon is brown, strong-brown, reddish-brown, reddish-yellow, or yellowish-red silty clay loam or silty clay. Reaction is mildly alkaline or moderately alkaline. Seams and pockets of salt crystals and concretions are present in the B22t and B3 horizons.

FdA—Foard silt loam, 0 to 1 percent slopes. This is a nearly level soil. Included in mapping are about 10 to 15 percent areas of Hinkle soils.

The main concerns of management are maintaining soil structure and fertility, preventing the formation of a surface crust, and increasing the water intake rate. Grazing or tilling when the soil is wet breaks down soil structure, creates a surface crust, and decreases the water intake rate, which tends to make the soil droughty. Crop residue should be returned to the soil. Tillage should be kept to a minimum, and row crops should be planted on the contour. Chemical amendments, such as gypsum, may be beneficial.

This soil is used mainly for small grain (fig. 4) and cotton. Small areas are used for tame pasture. Capability unit IIs–1; Hardland range site; pasture and hay group 8D; tree and shrub group 6.

Gotebo Series

The Gotebo series consists of moderately deep, well-drained, gently sloping to moderately steep soils on uplands. These soils formed in material weathered from siltstone or shale under a cover of native grasses.

In a representative profile the surface layer is brown loam about 6 inches thick. The next layer is about 3 inches of grayish-brown silt loam. The subsoil is light brownish-gray or light-gray silt loam. Weathered siltstone is at a depth of about 30 inches.

Permeability is moderate. The available water capacity is medium.

Representative profile of Gotebo loam, 5 to 12 percent slopes, 2,000 feet north and 600 feet east of the southwest corner of sec. 18, T. 7 N., R. 17 W.:

A11—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate, medium, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

A12—6 to 9 inches, grayish-brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; moderate, medium, granular structure; slightly hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

B2—9 to 20 inches, light brownish-gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; moderate, medium, subangular blocky structure; hard, firm; few, thin, discontinuous strata of siltstone; calcareous; moderately alkaline; gradual, smooth boundary.

B3—20 to 30 inches, light-gray (2.5Y 7/2) silt loam, light brownish gray (2.5Y 6/2) moist; weak, medium, granular structure; slightly hard, firm; common strata of weathered siltstone that become more laminar with increasing depth; calcareous; moderately alkaline; clear, smooth boundary.

C—30 to 32 inches, white (10Y 8/2), weathered, calcareous siltstone.

The solum ranges from 20 to 40 inches in thickness. Depth to secondary lime ranges from 4 to 30 inches. Texture of all horizons below the A11 horizon is loam or silt loam.

The A horizon is dark brown, brown, grayish brown, dark yellowish brown, dark grayish brown, or yellowish brown. Reaction is neutral to moderately alkaline.

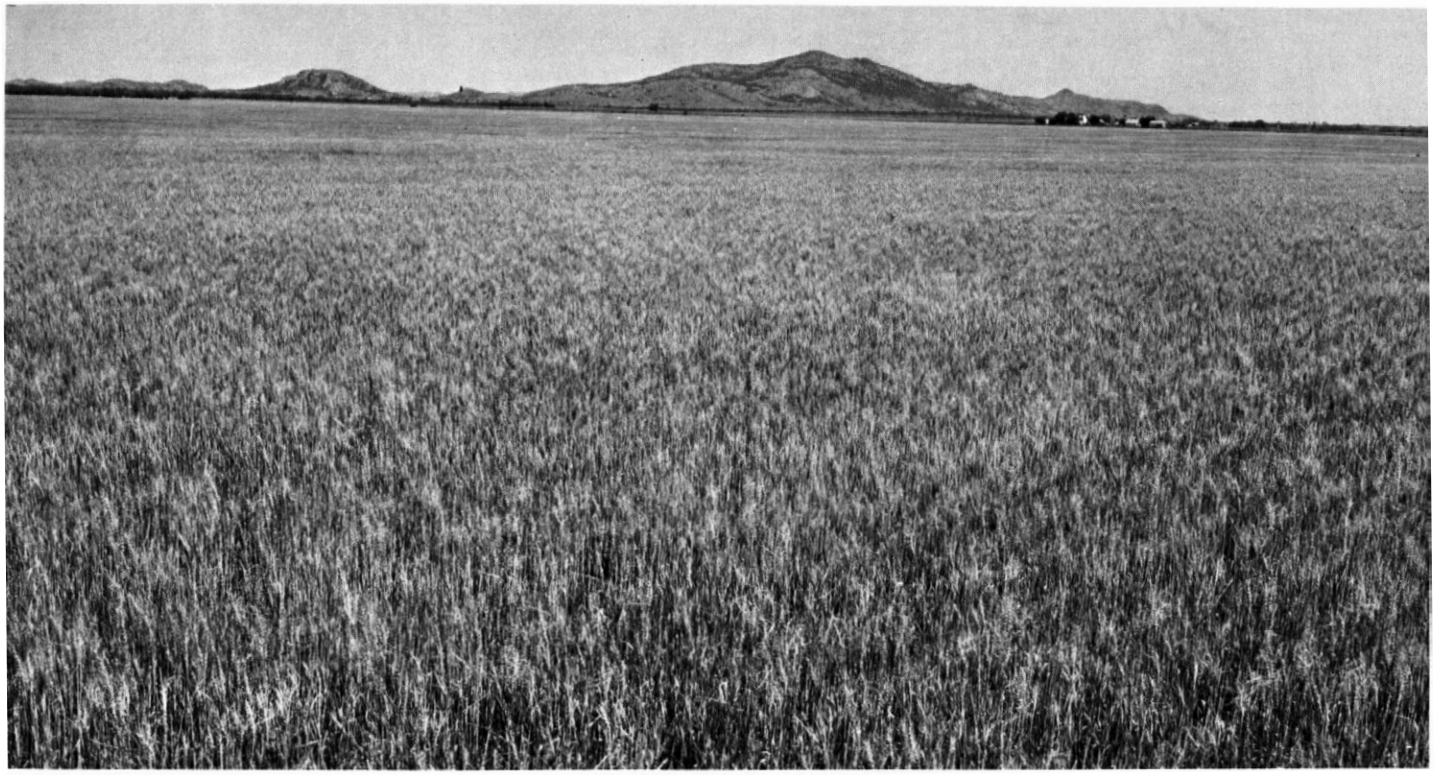


Figure 4.—An area of Foard silt loam, 0 to 1 percent slopes, in small grain.

The B2 horizon ranges from dark grayish brown to light yellowish brown. Reaction is mildly alkaline or moderately alkaline. The B3 horizon is grayish brown to yellow. It is moderately alkaline or strongly alkaline and is calcareous. The C horizon is similar to the B3 horizon in color but is white in places. It is weathered, calcareous siltstone or shale.

GbE—Gotebo loam, 5 to 12 percent slopes. This sloping and strongly sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are spots of Vernon soils, about 10 percent areas of soils that are similar to this Gotebo soil but have a redder subsoil and underlying material, and about 5 percent outcrops of limestone interbedded with siltstone.

This soil is used mainly for range. Capability unit VIe–4; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

GcF—Gotebo-Rock outcrop complex, 3 to 20 percent slopes. This complex consists of gently sloping to moderately steep soils on uplands. It is about 60 percent Gotebo loam, 30 percent Rock outcrop, 5 percent Vernon soils, and 5 percent Talpa soils. The Gotebo soil and Rock outcrop are so intermingled that it is impractical to map them separately. The Rock outcrop part of this complex is a land type that consists of clayey shale and in many areas is covered by flat limestone fragments 12 to 24 inches thick.

These soils are used for range. Both parts in capability unit VIIs–5; Gotebo part in Loamy Prairie range site, Rock outcrop part not assigned to a range site; not assigned to a pasture and hay group; both parts in tree and shrub group 9.

Grandfield Series

The Grandfield series consists of deep, well-drained, nearly level or gently sloping soils on uplands. These soils formed in alluvial or eolian sediment under a cover of native grasses.

In a representative profile the surface layer is reddish-brown loamy fine sand about 12 inches thick. The upper 12 inches of the subsoil is reddish-brown fine sandy loam, and the lower 26 inches is yellowish-red sandy clay loam. The underlying material is reddish-yellow loamy fine sand to a depth of 70 inches.

Permeability is moderate. The available water capacity is medium.

Representative profile of Grandfield loamy fine sand, 0 to 3 percent slopes, 500 feet west and 150 feet north of the southeast corner of the NE¼ sec. 21, T. 6 N., R. 20 W.:

A1—0 to 12 inches, reddish brown (5YR 4/3) loamy fine sand, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

B21t—12 to 24 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, very friable; clay bridges between sand grains; neutral; gradual, smooth boundary.

B22t—24 to 50 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, medium, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, very friable; moderately alkaline; clear, smooth boundary.

C—50 to 70 inches, reddish-yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; structureless; loose; moderately alkaline.

The solum ranges from 50 to 60 inches in thickness.

The A horizon is brown, dark-brown, reddish-brown, reddish gray, dark reddish-gray, or dark reddish-brown loamy fine sand or fine sandy loam. Reaction is neutral or mildly alkaline.

The B2t horizon is reddish-brown, yellowish-red, and reddish-brown fine sandy loam or sandy clay loam. It is 18 to 30 percent clay in the upper 20 inches. Reaction is mildly alkaline or moderately alkaline.

The C horizon is reddish-brown, yellowish-red, or reddish-yellow stratified loamy fine sand, fine sand, or fine sandy loam.

GnB—Grandfield loamy fine sand, 0 to 3 percent slopes. This nearly level and very gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are about 20 percent areas of Meno soils and spots of Grandfield fine sandy loam, 0 to 1 percent slopes.

The main concerns of management are controlling soil blowing and maintaining fertility. Returning a large amount of residue to the soil and adding plant nutrients help to maintain fertility and control soil blowing. Delaying tillage in spring during the period of critical soil blowing also helps to control soil blowing. Where row crops are grown, the rows should be planted perpendicular to the direction of the prevailing wind to reduce soil blowing. Other important management practices are stubble mulching, growing cover crops, and keeping tillage to a minimum and tilling at variable depths.

This soil is used mainly for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–6; Deep Sand range site; pasture and hay group 9A; tree and shrub group 5.

GrB—Grandfield fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is fine sandy loam. Included in mapping are spots of Altus and Tillman soils.

The main concerns of management are reducing soil blowing and erosion and maintaining fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used mainly for cultivated crops, such as wheat, grain sorghum, cotton, alfalfa, and tame pasture. Capability unit IIIe–3; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

Hardeman Series

The Hardeman series consists of deep, well-drained, very gently sloping to sloping soils on uplands. These soils formed in loamy eolian material under a cover of native grasses.

In a representative profile the surface layer is brown fine sandy loam about 7 inches thick. The next layer is about 9 inches of reddish-brown fine sandy loam. The subsoil is reddish-brown fine sandy loam about 18 inches thick. The underlying material is reddish-brown fine sandy loam to a depth of 65 inches.

Permeability is moderately rapid. The available water capacity is medium.

Representative profile of Hardeman fine sandy loam, 1 to 3 percent slopes, 1,200 feet north and 350 feet east of the southwest corner of the NW¼ sec. 35, T. 5 N., R. 19 W.:

Ap—0 to 7 inches, brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; weak, fine, granular structure; soft, very friable; mildly alkaline; clear, smooth boundary.

A1—7 to 16 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; moderate, fine, granular structure; slightly hard, very friable; mildly alkaline; clear, smooth boundary.

B2—16 to 34 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; slightly hard, very friable; few films and threads of calcium carbonate; moderately alkaline; gradual, smooth boundary.

C—34 to 65 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; massive; slightly hard, very friable; few threads and seams of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 30 to 50 inches in thickness. Depth to calcium carbonate ranges from 10 to 34 inches. The lower part of the A horizon, the B horizon, and the C horizon are very fine sandy loam, fine sandy loam, or loam that average 12 to 18 percent clay.

The A horizon is brown or reddish brown. Reaction is mildly alkaline or moderately alkaline. The B horizon is reddish brown or red. The C horizon is yellowish red, reddish brown, or red. It ranges from barely visible films and threads of calcium carbonate to about 5 percent calcium carbonate in the form of soft, powdery masses.

HaB—Hardeman fine sandy loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are about 20 percent areas of Dill soils, mainly in the northeastern part of the county.

The main concerns of management are reducing soil blowing and maintaining soil structure and fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depths, and planting row crops perpendicular to the prevailing wind.

This soil is used mainly for wheat, grain sorghum, cotton, and alfalfa. Small areas are used for improved pasture. Capability unit IIIe–4; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 7.

HaC—Hardeman fine sandy loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. Included in mapping are about 5 percent areas of Dill soils and 10 percent areas of Grandfield soils.

The main concerns of management are reducing erosion and maintaining soil structure and fertility. Some important management practices are returning all crop

residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depths, and installing terraces that have protected outlets.

This soil is used mainly for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–5; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 7.

HaD—Hardeman fine sandy loam, 5 to 8 percent slopes. This sloping soil is on uplands. Included in mapping, and making up about 10 percent each of the acreage, are areas of Dill and Grandfield soils.

The main concerns of management are maintaining fertility and controlling soil blowing and erosion. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets. These practices help maintain fertility and decrease the hazards of soil blowing and erosion.

This soil is used mainly for wheat, grain sorghum, and tame pasture. Capability unit IVe–3; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 7.

Hinkle Series

The Hinkle series consists of deep, moderately well drained, nearly level to gently sloping soils on uplands. These soils formed in material weathered from alluvium or residuum of clay beds under a cover of native grasses.

In a representative profile the surface layer is pinkish-gray silt loam about 7 inches thick. The upper 14 inches of the subsoil is dark-brown silty clay loam, the middle 24 inches is brown silty clay loam, and the lower 20 inches is reddish-brown silty clay loam.

Permeability is very slow. The available water capacity is low.

Representative profile of Hinkle silt loam in an area of St. Paul-Hinkle complex, 0 to 1 percent slopes, 2,000 feet north and 900 feet west of the southeast corner of sec. 23, T. 2 N., R. 17 W.:

Ap—0 to 7 inches, pinkish-gray (7.5YR 6/2) silt loam, dark brown (7.5YR 4/2) moist; weak, fine, granular structure moist, massive dry; hard, friable; upper ¼ inch is light-brown (7.5YR 6/4) vesicular crust; neutral; abrupt, smooth boundary.

B21t—7 to 21 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, blocky structure; hard, firm; patchy clay films on faces of peds; few threads and soft bodies of salt; few soft masses of calcium carbonate; calcareous; mildly alkaline; clear, smooth boundary.

B22t—21 to 45 inches, brown (7.5YR 5/2) silty clay loam, dark brown (7.5YR 4/2) moist; moderate, fine, blocky structure; hard, firm; nearly continuous clay films on faces of peds; common threads and soft bodies of salt; few soft masses of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

B3—45 to 65 inches, reddish-brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; weak, fine, subangular blocky structure; slightly hard, friable; patchy clay films on faces of peds; common threads and soft bodies of salt; few soft masses of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 inches to more than 60 inches in thickness. Depth to soft powdery lime ranges from 21 to 30 inches.

The A horizon is pinkish gray, brown, dark brown, light brown, dark reddish gray, reddish brown, reddish gray, or light reddish brown. Reaction ranges from slightly acid to moderately alkaline.

The B2t horizon is brown, dark-brown, reddish-brown, red, light-red, dark grayish-brown, grayish-brown, dark yellowish-brown, or yellowish-brown clay loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline. This horizon is 15 to 25 percent exchangeable sodium; the electrical conductivity of the saturated extract is about 2 to 6 millimhos per centimeter. The B3 horizon is reddish-brown, yellowish-red, or red clay loam or silty clay loam.

Hinkle soils in Kiowa County are mapped only with Carey, St. Paul, and Tillman soils.

Hollister Series

The Hollister series consists of deep, well-drained, nearly level or very gently sloping soils on uplands. These soils formed in clayey sediment under a cover of native grasses.

In a representative profile the surface layer is dark-brown silty clay loam about 10 inches thick. The upper 28 inches of the subsoil is dark-brown silty clay loam, and the lower 47 inches is yellowish-red or red silty clay loam. Shale is at a depth of about 85 inches.

Permeability is slow. The available water capacity is high.

Representative profile of Hollister silty clay loam, 0 to 1 percent slopes, 750 feet west and 300 feet north of the southeast corner of sec. 32, T. 6 N., R. 17 W.:

A1—0 to 10 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; weak and moderate, medium, granular structure; hard, friable; mildly alkaline; clear, smooth boundary.

B1—10 to 18 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky structure; very hard, firm; moderately alkaline; clear, smooth boundary.

B21t—18 to 28 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, fine, prismatic structure parting to strong, fine and medium, blocky; extremely hard, very firm; few cracks filled with dark-brown (7.5YR 2/2) material; nearly continuous clay films on faces of peds; moderately alkaline; gradual, wavy boundary.

B22t—28 to 38 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, fine, prismatic structure parting to moderate, medium, blocky; extremely hard, very firm; few cracks filled with dark-brown (7.5YR 3/2) material; few shiny pressure surfaces; about 10 percent soft masses of calcium carbonate; moderately alkaline; gradual, wavy boundary.

B23t—38 to 52 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; few, fine, distinct, red mottles; weak, fine, prismatic structure parting to moderate, medium, subangular blocky; extremely hard, very firm; few slickensides; few cracks filled with dark-brown (7.5YR 3/2) material; few fine crystals of gypsum; few films of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B24t—52 to 75 inches, red (2.5YR 4/6) silty clay loam, dark red (2.5YR 3/6) moist; moderate, medium, subangular blocky structure; extremely hard, very firm; few cracks filled with dark-brown (7.5YR 3/2) material; calcareous; moderately alkaline; gradual, wavy boundary.

B3&C—75 to 85 inches, B3 part is red (2.5YR 4/6) silty clay loam, dark red (2.5YR 3/6) moist, and has weak, fine, subangular blocky structure; C part is greenish-

gray (5GY 6/1) silt loam, greenish gray (5GY 5/1) moist, and has thin, platy structure; extremely hard, very firm; calcareous; moderately alkaline; clear, smooth boundary.

C—85 to 95 inches, red (2.5YR 4/6) silty shale, dark red (2.5YR 3/6) moist; weak, blocky structure; extremely hard, very firm; few, medium, greenish-gray (5GY 6/1) masses; calcareous; moderately alkaline.

The solum is more than 60 inches thick. The A and B1 horizons are brown, dark brown, grayish brown, or dark grayish brown. The B1 horizon is clay loam or silty clay loam. The B2 horizon is brown, dark brown, grayish brown, or dark grayish brown and grades to reddish yellow, yellowish red, light red, or red in the lower part. The B2t, B3, and C horizons are clay loam, silty clay loam, or clay.

HoA—Hollister silty clay loam, 0 to 1 percent slopes. This nearly level soil is on uplands. It has the profile described as representative of the series. Included in mapping, and making up about 15 percent of the acreage, are areas of soils that are similar to this Hollister soil, but the lower part of the subsoil has chroma of 4 or less or the clay content decreases by 20 percent from the maximum. Also included are about 15 percent areas of Tillman soils.

The main concern of management is maintaining soil structure. Grazing or tilling the soil when it is wet breaks down the soil structure and reduces the water intake rate. Excessive tillage pulverizes the surface layer and makes it susceptible to soil blowing. Even though erosion is not a hazard, contour tillage or planting crops across the slope helps to reduce runoff.

This soil is used for wheat, grain sorghum, and cotton. Small areas are used for pasture. Most of the crops generally grown on this soil produce a large amount of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIc–1; Hardland range site; pasture and hay group 8A; tree and shrub group 6.

HoB—Hollister silty clay loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. Included in mapping are about 15 percent areas of soils that are similar to this Hollister soil, but in which the lower part of the subsoil has chroma of 4 or less or the clay content decreases by 20 percent from the maximum within 60 inches of the surface. Also included are about 5 percent areas of Tillman soils.

The main concerns of management are maintaining soil structure, increasing the water intake rate, and controlling erosion. Grazing or tilling when the soil is wet breaks down the soil structure and reduces the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIe–3; Hardland range site; pasture and hay group 8A; tree and shrub group 6.

HoB2—Hollister silty clay loam, 1 to 3 percent slopes, eroded. This very gently sloping soil is on uplands. It has a profile similar to the one described as representative of the series, but the plow layer is a mixture of the surface layer and subsoil on about 60 percent of the area. Small rills and gullies are common. Included in mapping are areas of Tillman soils that make up about 15 percent of the acreage.

The main concerns of management are maintaining soil structure, increasing the water intake rate, and controlling erosion. Grazing or tilling when the soil is wet breaks down soil structure and reduces the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used mainly for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–1; Hardland range site; pasture and hay group 8A; tree and shrub group 6.

Indiahoma Series

The Indiahoma series consists of deep, well-drained, very gently sloping or gently sloping soils on uplands. These soils formed in clayey sediment under a cover of native grasses.

In a representative profile the surface layer is very dark grayish-brown silty clay loam about 13 inches thick. The upper 13 inches of the subsoil is very dark grayish-brown clay, the middle 17 inches is dark-brown clay, and the lower 17 inches is dark reddish-brown clay.

Permeability is very slow. The available water capacity is high.

Representative profile of Indiahoma silty clay loam, 1 to 3 percent slopes, 1,700 feet east and 450 feet north of the southwest corner of sec. 36, T. 2 N., R. 16 W.:

A1—0 to 13 inches, very dark grayish-brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; strong, fine and medium, granular structure; hard, firm; neutral; gradual, smooth boundary.

B21—13 to 26 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; compound; moderate, coarse, prismatic structure and moderate, medium, blocky; extremely hard, very firm; slightly darker coating on ped surfaces; few concretions of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

B22—26 to 43 inches, dark-brown (7.5YR 3/2) clay, very dark brown (7.5YR 2/2) moist; many intersecting slickensides and wedge-shaped peds; extremely hard, very firm; few concretions of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

B3—43 to 60 inches, dark reddish-brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 2/4) moist; common intersecting slickensides and wedge-shaped peds; extremely hard, very firm; cracks filled with dark-colored material from B22 horizon; common concretions of calcium carbonate; common soft limy spots; calcareous; moderately alkaline.

The solum ranges from 40 inches to more than 72 inches in thickness in the depressions and from 20 inches to more than 40 inches on the highs. Intersecting slickensides are between depths of 14 and 30 inches. The soil is calcareous between depths of 10 and 32 inches. Distance between the center of the high and the center of the low is 5 to 11.5 feet.

The A horizon is very dark grayish brown, brown, dark brown, dark yellowish brown, dark grayish brown, grayish brown, or yellowish brown. Reaction is neutral or mildly alkaline.

The B2 horizon is the same color as the A horizon. It is silty clay or clay. Reaction is mildly alkaline or moderately

alkaline. The B3 horizon is dark reddish brown, reddish brown, yellowish red, dark red, or red.

InB—Indiahoma silty clay loam, 1 to 3 percent slopes. This very gently sloping soil has gilgai microrelief (fig. 5). It has the profile described as representative of the series. Included in mapping are spots of Vernon and Tillman soils and soils that are similar to this Indiahoma soil but have carbonates below a depth of 32 inches.

The main concerns of management are maintaining soil structure, increasing the water intake rate, and controlling erosion. Grazing or tilling when the soil is wet breaks down the soil structure and reduces the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, pasture, and native range. Capability unit IIIe–1; Hardland range site; pasture and hay group 7A; tree and shrub group 6.

InC—Indiahoma silty clay loam, 3 to 5 percent slopes. This gently sloping soil has gilgai microrelief. Included in mapping are spots of Tillman and Vernon soils and soils that are similar to this Indiahoma soil but have carbonates at a depth of less than 10 inches.

The main concerns of management are maintaining soil structure, controlling erosion, and increasing the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets. These practices tend to maintain soil structure, reduce the hazard of erosion, prevent crusting, and increase the water intake rate.

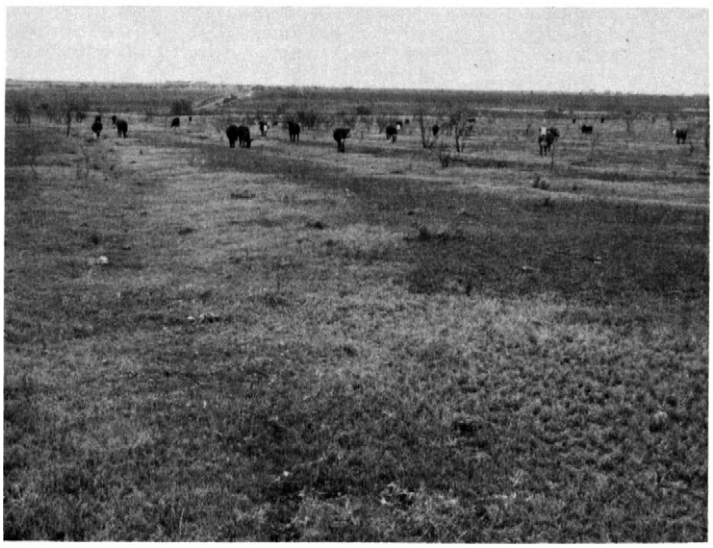


Figure 5.—Gilgai microrelief in an area of Indiahoma silty clay loam, 1 to 3 percent slopes. The dark-colored areas are microridges; the light-colored areas are microbasins.

This soil is used for wheat, grain sorghum, cotton, pasture, and native range. Capability unit IVe–1; Hardland range site; pasture and hay group 7A; tree and shrub group 6.

Lawton Series

The Lawton series consists of deep, well-drained, very gently sloping to sloping soils on uplands. These soils formed in old alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is dark-brown loam about 9 inches thick. The upper 17 inches of the subsoil is reddish-brown clay loam, the middle 19 inches is red clay loam, and the lower 15 inches or more is reddish-brown gravelly loam.

Permeability is moderately slow. The available water capacity is high.

Representative profile of Lawton loam, 1 to 3 percent slopes, 1,400 feet west and 250 feet north of the southeast corner of sec. 35, T. 4 N., T. 16 W.:

A1—0 to 9 inches, dark-brown (7.5YR 4/2) loam, dark brown (7.5 YR 3/2) moist; strong, medium, granular structure; slightly hard, friable; few fine granitic pebbles; slightly acid; clear, smooth boundary.

B1—9 to 14 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; strong, medium, granular structure; slightly hard, friable; few fine granitic pebbles; neutral; clear, smooth boundary.

B21t—14 to 26 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium, blocky structure; hard, firm; nearly continuous clay films on faces of peds; common fine granitic pebbles; neutral; gradual, smooth boundary.

B22t—26 to 45 inches, red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; weak, coarse, prismatic structure parting to moderate, medium, blocky; very hard, very firm; patchy clay films on faces of peds; common fine granitic pebbles; neutral; clear, smooth boundary.

B3—45 to 60 inches, reddish-brown (5YR 5/4) gravelly loam, reddish brown (5YR 4/4) moist; weak, medium, blocky structure; hard, firm; about 15 percent, by volume, fine and medium granitic pebbles; few films of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 inches to more than 60 inches in thickness. The A horizon is brown, dark brown, or reddish brown. It is 0 to 5 percent, by volume, cobbles more than 3 inches in diameter and 1 to 10 percent, by volume, pebbles less than 3 inches in diameter. Reaction is neutral or slightly acid.

The B1 horizon is loam or clay loam. Reaction is neutral or slightly acid. The B2t and B3 horizons are brown, dark brown, strong brown, reddish brown, yellowish red, red, or reddish yellow. They are 1 to 35 percent, by volume, pebbles less than 3 inches in diameter. The B3 horizon is loam, clay loam, sandy clay loam, and their gravelly analogs. The B2t and B3 horizons are neutral to moderately alkaline.

LaB—Lawton loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It has the profile described as representative of the series. Including in mapping are about 10 percent areas of Tillman soils.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are stubble mulching, farming on the contour, using crop residue and adding plant nutrients as needed, growing cover crops, keeping tillage to a minimum and tilling at variable depths, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, alfalfa, and tame pasture. Capability unit IIe-1; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 6.

LaC—Lawton loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. Included in mapping are areas of Tillman soils that make up about 10 percent of the acreage.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–2; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 6.

LaC2—Lawton loam, 2 to 5 percent slopes, eroded. This very gently sloping or gently sloping, eroded soil is on uplands. It has a profile similar to the one decribed as representative of the series, but the reddish-brown plow layer is a mixture of the surface layer and upper part of the subsoil on about 50 percent of the area. Small rills and gullies are common in most areas. Included in mapping are about 10 percent areas of Tillman soils, 5 percent areas of Vernon soils, and 25 percent areas of soils that are similar to this Lawton soil but have a dark-colored surface layer less than 10 inches thick.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, installing terraces that have protected outlets, and planting high-residue, soil-maintaining crops.

This soil is used mainly for wheat, grain sorghum, and tame pasture. Capability unit IVe–4; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 6.

LaD—Lawton loam, 5 to 8 percent slopes. This sloping soil is on uplands. It has a profile similar to the one described as representative of the series, but the surface layer is reddish brown and there are reddish-gray mottles in the middle and lower parts of the profile. Included in mapping are about 5 percent areas of Rock outcrop; 10 percent areas of soils that are similar to this Lawton soil but have a clayey subsoil; 20 percent areas of soils that are similar to this Lawton soil but have a thick, dark-colored surface layer; 20 percent areas of soils that are similar to this Lawton soil but have a subsoil that is less than 35 percent clay; and spots of soil that have a surface layer of cobbly or gravelly loam.

The main concerns of management are maintaining soil structure and controlling erosion. Some important management practices are returning crop residue to the soil, tilling on the contour, keeping tillage to a minimum and tilling at variable depths, and installing terraces that have protected outlets. These practices help to maintain soil structure and control erosion.

This soil is used mainly for wheat, grain sorghum, and tame pasture. Capability unit IVe–2; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 6.

LbE—Lawton-Rock outcrop complex, 1 to 12 percent slopes. This complex consists of very gently sloping to sloping soils on uplands. Slopes range from 1 to 8 percent. It is about 60 percent Lawton loam, 20 percent Rock outcrop, and 20 percent soils that are similar to this Lawton soil but are stony throughout the surface layer and subsoil. The Lawton soil and Rock outcrop are so intermingled that it is impractical to map them separately. The Lawton soil in this complex has a profile similar to the one described as representative of the Lawton series, but bedrock is at a depth of about 42 inches. The Rock outcrop part of this complex is a land type that consists of gray anorthosite bedrock that in most places is bare or thinly mantled with soil material and boulders that rise abruptly from the surrounding landscape.

These soils are used for range. In some areas the soil material below the boulders is strongly weathered and easily excavated and is an excellent source of material for road surfaces. Both parts in capability unit VIe–8; Lawton part in Loamy Prairie range site, Rock outcrop part not assigned to a range site; Lawton part in pasture and hay group 8A, Rock outcrop part not assigned to a pasture and hay group; Lawton part in tree and shrub group 6, Rock outcrop in tree and shrub group 9.

Lincoln Series

The Lincoln series consists of deep, somewhat excessively drained, nearly level soils on flood plains. These soils formed in recent alluvium under a cover of native grass and a small overstory of trees.

In a representative profile the surface layer is reddish-brown loamy fine sand about 8 inches thick. The next layer is about 15 inches of reddish-yellow loamy fine sand. The next layer is reddish-yellow fine sand to a depth of 60 inches.

Permeability is rapid. The available water capacity is low.

Representative profile of Lincoln loamy fine sand, 300 feet south and 680 feet east of the northwest corner of sec. 10, T. 2 N., R. 18 W.:

A1—0 to 8 inches, reddish-brown (5YR 4/4) loamy fine sand, dark reddish brown (5YR 3/4) moist; weak, fine, granular structure; soft, very friable; calcareous; moderately alkaline; clear, smooth boundary.

C1—8 to 23 inches, reddish-yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; single grained; loose, very friable; few thin strata of fine sandy loam to clay loam; bedding planes are evident; calcareous; moderately alkaline; clear, smooth boundary.

C2—23 to 60 inches, reddish-yellow (5YR 7/6) fine sand, reddish yellow (5YR 6/6) moist; single grained; loose, very friable; few thin strata of clay loam in upper part; bedding planes are evident; calcareous; moderately alkaline.

The A horizon is reddish-brown or brown loamy fine sand, loam, fine sandy loam, or clay loam. Below a depth of 10 inches it is loamy fine sand or fine sand.

The C horizon is light reddish-brown, pink, reddish-yellow, or light-brown loamy fine sand or fine sand. It has strata less than 1 inch thick that are darker colored and contain more organic carbon than the rest of the soil. These strata range from fine sandy loam to clay loam.

Ln—Lincoln loamy fine sand. This nearly level soil is on flood plains that are occasionally flooded. The soil has the profile described as representative of the series. Included in mapping are spots of Yahola soils.

The main concerns of management are protecting the soil from flooding, maintaining fertility, and controlling soil blowing and erosion. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, and establishing perennial vegetation in natural drainageways. Seedbed preparation should be timed to avoid the critical period of soil blowing. Flooding can be reduced by watershed protection projects and detention dams.

This soil is used mainly for tame pasture. Very small areas are used for cultivated crops, such as wheat and grain sorghum. Capability unit IVs–3; Sandy Bottomland range site; pasture and hay group 3A; tree and shrub group 4.

Lo—Lincoln soils. These nearly level soils are on flood plains that are frequently flooded. The soils have a profile similar to the one described as representative of the Lincoln series, but the surface layer is loamy fine sand, fine sandy loam, loam, or clay loam. Included in mapping are spots of Yahola soils and soils that are similar to these Lincoln soils but have a thicker surface layer.

These soils are used for range. Small areas are used for tame pasture. Capability unit Vw–1; Sandy Bottomland range site; pasture and hay group 3A; tree and shrub group 4.

Lugert Series

The Lugert series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is reddish-brown loam about 16 inches thick. The subsoil is red loam about 26 inches thick. The underlying material is red loam to a depth of 65 inches.

Permeability is moderate. The available water capacity is high.

Representative profile of Lugert loam, 700 feet east and 700 feet south of the northwest corner of sec. 8, T. 6 N., R. 18 W.:

Ap—0 to 10 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; moderate, fine, granular structure; soft, very friable; neutral; clear, smooth boundary.

A1—10 to 16 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; strong, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B2—16 to 42 inches, red (2.5YR 4/6) loam, dark red (2.5YR 3/6) moist; moderate, medium, subangular blocky structure; slightly hard, friable; 2- to 3-inch bands of dark-red (2.5YR 3/6) loam; few films of calcium carbonate below a depth of 20 inches; calcareous; moderately alkaline; gradual, smooth boundary.

C—42 to 65 inches, red (2.5YR 5/6) loam, red (2.5YR 4/6) moist; massive; slightly hard, friable; 1- to 2-inch bands of dark-red (2.5YR 3/6) clay loam; visible films of calcium carbonate; calcareous; moderately alkaline.

Depth to secondary carbonates ranges from 15 to 36 inches.

The A horizon is brown, dark brown, dark reddish brown, reddish gray, dark reddish gray, or reddish brown. The Ap horizon is loam. The A1 horizon is loam, silt loam, or very fine sandy loam. Reaction is neutral or mildly alkaline.

The B2 horizon is brown, dark-brown, strong-brown, light-brown, reddish-yellow, reddish-brown, yellowish-red, light reddish-brown, red, or light-red loam, silt loam, or very fine sandy loam. Reaction is mildly alkaline or moderately alkaline. Bands of soil material occur in the B horizon that are one or two units darker than the matrix.

The C horizon has color and texture similar to the B2 horizon. Thin alternating bands of more clayey or more sandy material are below a depth of 30 inches.

Lu—Lugert loam. This nearly level soil is on flood plains that are subject to occasional flooding. Slopes are 0 to 1 percent. Included in mapping are spots of Port soils that make up about 10 percent of the acreage.

The main concerns of management are protecting the soil from occasional flooding and maintaining soil structure and fertility. Flooding can be reduced by watershed protection projects and detention dams. Another important management practice is growing cover crops along with low-residue crops.

This soil is used for wheat, grain sorghum, cotton, alfalfa, and tame pasture. Most of the crops generally grown produce large amounts of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIw–2; Loamy Bottomland range site; pasture and hay group 2A; tree and shrub group 1.

Mangum Series

The Mangum series consists of deep, well drained or moderately well drained, nearly level soils on flood plains. These soils formed in clayey sediment under a cover of native grasses.

In a representative profile the surface layer is reddish-brown silty clay about 10 inches thick. The upper 32 inches of the underlying material is red silty clay. The lower part of the underlying material is red clay to a depth of 60 inches.

Permeability is very slow. The available water capacity is high. These soils are frequently flooded.

Representative profile of Mangum silty clay in an area of Clairemont and Mangum soils, 600 feet east and 600 feet north of the southwest corner of sec. 25, T. 6 N., R. 17 W.:

A1—0 to 10 inches, reddish-brown (5YR 5/3) silty clay, reddish brown (5YR 4/3) moist; weak, medium, granular structure; hard, firm; calcareous; moderately alkaline; clear, smooth boundary.

C1—10 to 42 inches, red (2.5YR 4/6) silty clay, dark red (2.5YR 3/6) moist; massive; very hard, very firm; common shiny surfaces on faces of peds; few cracks filled with material from A1 horizon; few bedding planes; few soft masses and films of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

C2—42 to 60 inches, red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; massive; very hard, very firm; common thin strata of gravel; few fragments of shale; few soft masses and concretions of calcium carbonate; calcareous; moderately alkaline.

Cracks more than 1 centimeter wide extend from the surface to a depth of about 26 inches. The soil is calcareous silty clay or clay throughout.

The A horizon is reddish brown or brown. If the A horizon is more than 10 inches thick, its moist value and chroma are more than 3.5.

The C horizon is red or reddish brown. It has few or common films, threads, masses, or concretions of calcium carbonate.

Mangum soils in Kiowa County are mapped only with Clairemont and Vernon soils.

McLain Series

The McLain series consists of deep, moderately well drained, nearly level soils on terraces and flood plains. These soils formed in loamy or clayey sediment under a cover of native grasses and a few trees.

In a representative profile the surface layer is dark-brown silty clay loam about 15 inches thick. The upper 10 inches of the subsoil is reddish-brown silty clay, and the lower 11 inches is reddish-brown silty clay loam. The underlying material is reddish-brown silty clay loam to a depth of 60 inches.

Permeability is slow. The available water capacity is high.

Representative profile of McLain silty clay loam, 50 feet north and 1,600 feet east of the southwest corner of the NW¼ sec. 23, T. 7 N., R. 15 W.:

Ap—0 to 8 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; weak, medium, granular structure; slightly hard, friable; slightly acid; clear, smooth boundary.

A1—8 to 15 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B2t—15 to 25 inches, reddish-brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; moderate, medium, blocky structure; hard, firm; patchy clay films on faces of peds; calcareous; moderately alkaline; gradual, smooth boundary.

B3—25 to 36 inches, reddish-brown (5YR 4/4) silty clay loam, reddish brown (5YR 4/4) moist; weak, fine, blocky structure; hard, firm; calcareous; moderately alkaline; gradual, smooth boundary.

C—36 to 60 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; massive; very hard, very firm; many soft bodies of calcium carbonate and common concretions of calcium carbonate; calcareous; moderately alkaline.

The A horizon is dark reddish brown, dark brown, or very dark grayish brown. Reaction is slightly acid or mildly alkaline.

The B2t horizon is dark reddish-brown, dark reddish-gray, reddish-brown, reddish-gray, dusky-red, or weak-red silty clay loam, clay loam, or silty clay. Reaction is mildly alkaline or moderately alkaline. The B3 and C horizons are reddish brown, yellowish red, or red. The B3 horizon is silty clay loam, clay loam, or silty clay.

The C horizon is silt loam, loam, silty clay loam, clay loam, or silty clay. In places a buried A horizon is below a depth of 50 inches.

Mc—McLain silty clay loam. This nearly level soil is on flood plains or terraces that are subject to rare flooding. Slopes are 0 to 1 percent. Included in mapping are spots of Miller soils that make up about 5 percent of the acreage. The main concern of management is maintaining soil structure and fertility. Important management practices are keeping tillage to a minimum and tilling at variable depth and tilling on the contour where row crops are grown.

This soil is used for wheat (fig. 6), grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture. Most of the crops generally grown produce large amounts of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit I–1; Heavy Bottomland range site; pasture and hay group 2A; tree and shrub group 2.

Meno Series

The Meno series consists of deep, moderately well drained, nearly level or very gently sloping soils on uplands. These soils formed in stratified loamy alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is brown loamy fine sand about 9 inches thick. The next layer is about 12 inches of dark-brown loamy fine sand. The subsoil is dark-brown or brown sandy clay loam about 39 inches thick. The underlying material is mottled grayish-brown and strong-brown loam to a depth of 84 inches.

Permeability is moderate. The available water capacity is low. A perched water table is at a depth of 2 or 3 feet.

Representative profile of Meno loamy fine sand, 0 to 3 percent slopes, 500 feet south and 100 feet west of the northeast corner of sec. 3, T. 5 N., R. 20 W.:

Ap—0 to 9 inches, brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) moist; weak, fine, granular structure; soft, very friable; slightly acid; abrupt, smooth boundary.

A1—9 to 21 inches, dark-brown (7.5YR 4/4) loamy fine sand, dark brown (7.5YR 3/4) moist; weak, fine, granular structure; soft, very friable; slightly acid; clear, smooth boundary.

B21t—21 to 28 inches, dark-brown (7.5YR 4/4) sandy clay loam, dark brown (7.5YR 3/4) moist; few, fine, faint, grayish-brown mottles; moderate, medium, subangular blocky structure; slightly hard, friable; patchy clay films on faces of peds and bridging sand grains; slightly acid; gradual, smooth boundary.

B22t—28 to 39 inches, brown (7.5YR 4/4) sandy clay loam, dark brown (7.5YR 3/4) moist; moderate, medium,

Figure 6.—An excellent crop of wheat on McLain silty clay loam. This soil is highly productive and is rarely subject to flooding.

blocky structure; hard, firm; few dark-brown stains and gray coatings on faces of peds; patchy clay films on faces of peds and bridging sand grains; common dark concretions; slightly acid; gradual, smooth boundary.

B23t—39 to 60 inches, brown (10YR 5/3) sandy clay loam, dark grayish brown (10YR 4/2) moist; common, fine, prominent, yellowish-red mottles; moderate, medium, subangular blocky structure; extremely hard, friable; clay films bridging sand grains; slightly acid; clear, smooth boundary.

C—60 to 84 inches, mottled grayish-brown (10YR 5/2) and strong-brown (7.5YR 5/6) loam; massive; slightly hard, very friable; slightly acid.

The A horizon is brown or dark brown and is 20 to 30 inches thick. Reaction is medium acid to neutral.

The B2t horizon is brown, dark-brown, dark yellowish-brown, yellowish-brown, pale-brown, light yellowish-brown, brownish-yellow, strongly-brown, light-brown, or reddish-yellow fine sandy loam, sandy loam, or sandy clay loam.

The C horizon is loam. In places it is stratified with fine sandy loam or sandy clay loam.

MeB—Meno loamy fine sand, 0 to 3 percent slopes. This nearly level and very gently sloping soil is on uplands. It has a perched water table at a depth of 2 to 3 feet from February to June. Included in mapping are 15 percent areas of Grandfield soils and spots of Altus soils.

The main concerns of management are controlling soil blowing and maintaining soil structure and fertility. Returning a large amount of residue to the soil and adding plant nutrients help to maintain soil structure and fertility and control soil blowing. Delaying tillage in spring during the period of critical soil blowing also helps to control soil blowing. Other important management practices are stubble mulching, growing cover crops, and keeping tillage to a minimum and tilling at variable depths.

This soil is used for wheat, grain sorghum, cotton, and alfalfa. Capability unit IIe–4; Deep Sand range site; pasture and hay group 9C; tree and shrub group 5.

Miller Series

The Miller series consists of deep, moderately well drained, nearly level soils on flood plains. These soils formed in alluvium under a cover of native grasses.

In a representative profile the surface layer is brown clay about 10 inches thick. The subsoil is reddish-brown clay about 30 inches thick. The next layer is about 7 inches of brown silt loam. The next layer is brown silty clay loam to a depth of 72 inches.

Permeability is very slow. The available water capacity is high. These soils are subject to flooding.

Representative profile of Miller clay, 700 feet east, 300 feet north of the southwest corner of sec. 12, T. 6 N., R. 16 W.:

Ap—0 to 5 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; hard, firm; mildly alkaline; clear, smooth boundary.

A1—5 to 10 inches, brown (7.5YR 4/2) clay, dark brown (7.5YR 3/2) moist; moderate fine, granular structure; hard, firm; mildly alkaline; clear, smooth boundary.

B2—10 to 40 inches, reddish-brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate, medium, blocky structure; very hard, very firm; shiny surfaces on faces of peds; few slickensides that do not intersect; common vertical cracks filled with material from A1 horizon; few soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

A1b—40 to 47 inches, brown (7.5YR 5/2) silt loam, dark brown (7.5YR 4/2) moist; moderate, medium, blocky structure; slightly hard, firm; shiny surfaces on faces of some peds; few slickensides that do not intersect; few soft masses and concretions of calcium carbonate; calcareous; moderately alkaline; clear, smooth boundary.

IIB2b—47 to 72 inches, brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, blocky structure; hard, firm; shiny surfaces on faces of some peds; few crystals of gypsum; few masses of soft calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 30 inches to more than 60 inches in thickness. These soils are calcareous throughout the B2 horizon and have soft powdery lime within 30 inches of the surface. Cracks more than 1 centimeter wide extend from the surface to a depth of about 30 inches.

The A horizon is brown, dark reddish-gray, or reddish-brown loam, silt loam, silty clay loam, silty clay, or clay. Reaction is mildly alkaline or moderately alkaline.

The B2 horizon is reddish-brown or dark reddish-brown clay, silty clay, clay loam, or silty clay loam. It is 35 to 50 percent clay. Reaction is mildlly alkaline or moderately alkaline.

The Ab horizon is brown, dark brown, reddish brown, or dark reddish brown. It is similar to the B2 horizon in texture, but it is 25 to 35 percent clay.

The IIB2b horizon is similar to the A1b horizon in color, texture, and reaction. In places it is thinly stratified with lighter or darker colored silt loam or sand.

Mr—Miller clay. This nearly level soil is on flood plains that are subject to flooding. Slopes are 0 to 1 percent. The soil has the profile described as representative of the series. Included in mapping are 5 percent areas of Port soils; 10 percent areas of Miller soils, saline; 10 percent areas of soil that are similar to this Miller soil but have a less clayey subsoil; and spots of Hinkle soils and Natrustalfs.

The main concerns of management are protecting the soil from flooding, maintaining soil structure, and increasing the water intake rate. Flooding can be reduced by watershed protection projects and detention dams. This soil is high in content of clay, and the soil structure can be damaged if the soil is grazed or tilled when wet. The soil tends to form a crust, and this along with the high content of clay reduces the water intake rate.

This soil is used for cultivated crops, such as wheat, grain sorghum, and cotton. Small areas are used for tame pasture. Most of the crops grown on this soil produce large amounts of residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIIw–2; Heavy Bottomland range site; pasture and hay group 1A; tree and shrub group 2.

Ms—Miller soils, saline. These nearly level soils are on flood plains that are subject to flooding. Slopes are 0 to 1 percent. These soils have a profile similar to the one described as representative of the series, but the surface layer is loam, silt loam, silty clay loam, silty clay, or clay. Also, the soils are moderately affected or strongly affected by salinity in the surface layer and subsoil; electrical conductivity of the saturation extract is 4 to 10 millimhos per centimeter. Included in mapping are about 5 percent areas of Port soils, 10 percent areas of soils that are similar to these Miller soils but have a less clayey subsoil, 10 percent

areas of Miller clay that is not affected by salinity, and spots of Hinkle soils.

These soils are used mainly for grazing. Some areas are used for tame pasture. Capability unit IVs–2; Alkali Bottomland range site; pasture and hay group 2C; tree and shrub group 9.

Natrustalfs

Natrustalfs are deep, moderately well drained, nearly level or very gently sloping soils on uplands. These soils formed in material weathered from alluvium or residuum from clay beds under a cover of native grasses.

In a representative profile the surface layer is brown fine sandy loam about 7 inches thick. The next layer is about 7 inches of pinkish-gray loam. The upper 23 inches of the subsoil is brown clay loam, the middle 20 inches is light reddish-brown clay loam, and the lower 15 inches is yellowish-red silty clay loam.

Permeability is very slow. The available water capacity is medium.

Representative profile of Natrustalfs, 300 feet east and 900 feet north of the southwest corner of sec. 25, T. 6 N., R. 20 W.:

A11—0 to 7 inches, brown (7.5YR 5/2) fine sandy loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; the upper 1 inch is a vesticular crust; hard and massive dry; hard, friable; moderately alkaline; clear, smooth boundary.

A12—7 to 14 inches, pinkish-gray (7.5R 6/2) loam, dark brown (7.5YR 4/2) moist; moderate, fine, granular structure; slightly hard, friable; moderately alkaline; clear, smooth boundary.

B21t—14 to 37 inches, brown (7.5YR 5/4) clay loam, brown (7.5YR 4/4) moist; moderate, medium, subangular blocky structure; hard, firm; nearly continuous clay films on faces of peds; few organic stains on faces of peds; few fine concretions of calcium carbonate, few soft masses of calcium carbonate; few fine iron-manganese concretions; common salt crystals; calcareous; moderately alkaline; gradual, smooth boundary.

B22t—37 to 57 inches, light reddish-brown (5YR 6/4) clay loam, reddish brown (5YR 5/4) moist; weak, coarse, prismatic structure parting to moderate, fine, subangular blocky; hard, firm; nearly continuous clay films on surfaces of peds; common salt crystals; calcareous; moderately alkaline; gradual, smooth boundary.

B3—57 to 72 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; weak, medium, blocky structure; hard, firm; common soft masses of calcium carbonates; few salt crystals; calcareous; moderately alkaline.

Depth to soft masses of calcium carbonate ranges from 12 to 24 inches.

The A11 horizon is brown, dark brown, pinkish gray, light brown, dark grayish brown, dark, yellowish brown, grayish brown, yellowish brown, light yellowish gray, pale brown, light yellowish brown, or very dark grayish brown. The A12 horizon is similar to the A11 horizon in color. It is loam or silt loam. Reaction of the A horizon is slightly acid to moderately alkaline.

The B2t horizon is brown, light-brown, light reddish-brown, or reddish-brown clay loam or silty clay loam. It has common concretions of salt. It ranges from 15 to about 25 percent in content of exchangeable sodium. The electrical conductivity of the saturated extract is about 2 to 6 millimhos per centimeter. The B3 horizon is brown, strong-brown, reddish-gray, reddish-brown, or yellowish red clay loam or silty clay loam. Reaction of the B horizon is mildly alkaline or moderately alkaline.

Na—Natrustalfs. These nearly level or very gently sloping soils are on uplands. Slopes range from 0 to 2 percent. Included in mapping are areas of Foard soils that make up about 5 percent of the acreage.

The main concerns of management are maintaining soil structure, reducing surface crusting, reducing salinity, and controlling erosion. Some important management practices are returning all crop residue to the soil, stubble mulching, adding plant nutrients as needed, keeping tillage to a minimum and tilling at the proper time and at a shallow depth, and establishing perennial vegetation in natural drainageways. Salt concentration reduces the water intake rate, causes surface crusting, and damages soil structure. These effects make the soil droughty and retard the emergence of seedlings. Chemical amendments, such as gypsum, may be beneficial.

These soils are used only for range. Capability unit IVs–1; Slickspot range site; pasture and hay group 8D; tree and shrub group 9.

Port Series

The Port series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy alluvial sediment under a cover of native grasses and an overstory of hardwood trees.

In a representative profile the surface layer is dark-brown silty clay loam about 26 inches thick. The upper 14 inches of the subsoil is reddish-brown silty clay loam, and the lower 25 inches or more is red silty clay loam.

Permeability is moderate. The available water capacity is high.

Representative profile of Port silty clay loam, 700 feet north and 600 feet west of the southeast corner of sec. 17, T. 6 N., R. 18 W.:

Ap—0 to 8 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

A1—8 to 26 inches, dark-brown (7.5YR 3/2) silty clay loam, very dark brown (7.5YR 2/2) moist; strong, fine, granular structure; slightly hard, friable; mildly alkaline; clear, smooth boundary.

B21—26 to 40 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; moderate, fine, subangular blocky structure; hard, firm; few films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B22—40 to 65 inches, red (2.5YR 4/6) silty clay loam, dark red (2.5YR 3/6) moist; moderate, fine, subangular blocky structure; hard, firm; few films of calcium carbonate; calcareous; moderately alkaline.

Depth to secondary carbonates ranges from 25 to 48 inches. The A horizon ranges from 20 to 40 inches in thickness. It is dark reddish gray or dark brown. Reaction is neutral or mildly alkaline. The B2 horizon is reddish-brown, red, or yellowish-red silt loam, loam, or silty clay loam. Reaction is mildly alkaline or moderately alkaline. In places there are thin strata of finer textured or coarser textured material below the B21 horizon.

Po—Port silty clay loam. This nearly level soil is on flood plains that are occasionally subject to flooding. Slopes are 0 to 1 percent. Included in mapping are spots of Miller and Lugert soils.

The main concerns of management are maintaining soil structure and fertility and protecting the soil from flooding. Flooding can be reduced by watershed protection projects and detention dams. Another important practice is growing a cover crop along with low-residue crops.

This soil is used for wheat, grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture grasses. Most crops grown on this soil produce large amounts of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIw–2; Loamy Bottomland range site; pasture and hay group 2A; tree and shrub group 1.

Pratt Series

The Pratt series consists of deep, well-drained, gently sloping to moderately steep soils on uplands. These soils formed in sandy eolian material under a cover of native grass.

In a representative profile the surface layer is brown loamy fine sand about 12 inches thick. The subsoil is reddish-brown loamy fine sand about 30 inches thick. The underlying material is light-brown fine sand to a depth of 60 inches.

Permeability is rapid. The available water capacity is low.

Representative profile of Pratt loamy fine sand in an area of Tivoli-Pratt complex, 3 to 15 percent slopes, 150 feet north and 1,200 feet west of the southeast corner of the NW¼ sec. 33, T. 6 N., R. 20 W.:

A1—0 to 12 inches, brown (7.5YR 5/2) loamy fine sand, brown (7.5YR 4/2) moist; weak, fine, granular structure; soft, very friable; many fine roots; neutral; clear, smooth boundary.

B2t—12 to 42 inches, reddish-brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/3) moist; weak, fine, granular structure; soft, very friable; few fine roots; neutral; clear, smooth boundary.

C—42 to 60 inches, light-brown (7.5YR 6/4) fine sand, brown (7.5YR 5/4) moist; single grained; loose; neutral.

The solum ranges from 24 to 50 inches in thickness. The A horizon is medium acid to neutral. The B2t horizon is reddish gray, reddish brown, light reddish brown, brown, or light brown. It is at least 3 percent more clay than the A horizon. Reaction is neutral to medium acid. The C horizon is light yellowish brown, light brown, or pale brown.

Pratt soils in Kiowa County are mapped only with Tivoli soils.

Reinach Series

The Reinach series consists of deep, well-drained, nearly level soils on terraces. These soils formed in loamy alluvial sediment under a cover of native grasses and an overstory of trees.

In a representative profile the surface layer is dark-brown loam about 14 inches thick. The subsoil is reddish-brown loam about 24 inches thick. The underlying material is reddish-brown or yellowish-red loam to a depth of 72 inches.

Permeability is moderate. The available water capacity is high.

Representative profile of Reinach loam, 200 feet north and 400 feet west of the southeast corner of the NW¼ sec. 12, T. 7 N., R. 14 W.:

Ap—0 to 8 inches, dark-brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; slightly hard, very friable; neutral; clear, smooth boundary.

A1—8 to 14 inches, dark-brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate, fine and medium, granular structure; slightly hard, very friable; mildly alkaline; gradual, smooth boundary.

B2—14 to 38 inches, reddish-brown (5YR 4/3) loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; slightly hard, friable; mildly alkaline; gradual, smooth boundary.

C1—38 to 50 inches, reddish-brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; massive; slightly hard, very friable; few films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C2—50 to 72 inches, yellowish-red (5YR 5/6) loam, yellowish red (5YR 4/6) moist; massive; soft, very friable; few films of calcium carbonate; calcareous; moderately alkaline.

Depth to secondary lime ranges from 20 to 60 inches. The A horizon is brown, dark brown, dark reddish gray, or reddish brown. Reaction is neutral or mildly alkaline. The B2 horizon is neutral to moderately alkaline. The C horizon is reddish-brown, red, or yellowish-red loam, silt loam, or very fine sandy loam. In places it is stratified with coarser textured or finer textured material below a depth of 50 inches.

Re—Reinach loam. This nearly level soil is on terraces that are subject to rare flooding. Slopes are 0 to 1 percent. Included in mapping are spots of McLain and Port soils.

The main concern of management is maintaining soil structure and fertility. Some important management practices are returning all crop residue to the soil, adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, and tilling on the contour where row crops are grown.

The soil is used for wheat, grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture. Capability unit I–1; Loamy Bottomland range site; pasture and hay group 2A; tree and shrub group 1.

Rock Outcrop

Rk—Rock outcrop. This land type consists of steep and very steep, nearly barren outcrops of granite and about 5 percent loamy soil material less than 4 inches thick. Rock outcrop is on uplands in the southern part of the county. The granite is elevated 100 to 500 feet above the surrounding plain. Slopes range from 20 to 45 percent. Included in mapping are spots of Brico soils that make up about 5 percent of the acreage.

Rock outcrop is not suited to crops and has little value for grazing. It is used mainly for wildlife habitat and as a source of construction material. Capability unit VIIIs–1; range site, pasture and hay group, and tree and shrub group not assigned.

RoF—Rock outcrop-Brico complex, 8 to 50 percent slopes. This complex is on uplands. It is about 60 percent Rock outcrop, 30 percent Brico cobbly loam, and 10 percent Lawton soil. The Brico soil is strongly sloping, and Rock outcrop is strongly sloping to very steep. Rock outcrop consists of granitic boulders 10 inches to 6 feet in diameter and granitic outcrop. It is barren of vegetation except for occasional patches

of moss. The Brico soil occurs between areas of Rock outcrop. Rock outcrop and the Brico soil occur in such an intricate pattern that it is not practical to map them separately.

These soils are used only for range. Both parts in capability unit VIIs–3; Rock outcrop part in Hilly Stony range site, Brico part in Boulder Ridge range site; pasture and hay group not assigned; both parts in tree and shrub group 9.

Roscoe Series

The Roscoe series consists of deep, moderately well drained, nearly level soils on uplands. These soils formed in clayey sediment under a cover of native grasses and widely spaced scrubby trees.

In a representative profile the surface layer is dark-gray clay about 15 inches thick. The next layer is about 39 inches of gray clay. The underlying material is light-gray clay to a depth of 80 inches.

Permeability is very slow. The available water capacity is high.

Representative profile of Roscoe clay, 2,100 feet south and 700 feet east of the northwest corner of sec. 34, T. 5 N., R. 18 W.:

Ap—0 to 6 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, fine, granular structure; very hard, firm, sticky and plastic; calcareous; moderately alkaline; abrupt, smooth boundary.

A11—6 to 15 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; moderate, fine, subangular blocky structure; very hard, firm, sticky and plastic; shiny pressure surfaces on peds; calcareous; moderately alkaline; gradual, wavy boundary.

A12—15 to 33 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, medium, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; common wedge-shaped aggregates; common intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.

AC—33 to 54 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, medium, subangular blocky structure; extremely hard, very firm; few wedge-shaped aggregates; common intersecting slickensides; calcareous; moderately alkaline; gradual, wavy boundary.

C—54 to 80 inches, light-gray (5Y 7/1) clay, gray (5Y 6/1) moist; few, fine, distinct, yellowish-brown mottles; massive; very hard, firm; few soft bodies of calcium carbonate; calcareous; moderately alkaline.

Areas that have not been farmed have a microrelief of knolls that are 5 to 8 inches higher than the depressions. The distance from the center of the knoll to the center of the depression ranges from 7 to 10 feet. The soil is clay throughout.

The A and AC horizons are gray (10YR 5/1) or dark gray (10YR 4/1). The A horizon ranges from neutral on the knolls to moderately alkaline and calcareous in the depressions. The C horizon is gray or light gray (5Y 6/1, 7/1). It is 1 to 10 percent bodies, films, or threads of calcium carbonate.

Rs—Roscoe clay. This slightly depressional or nearly level soil is on uplands. Slopes are 0 to 1 percent. The soil is subject to ponding after heavy rain. Included in mapping are spots of Hollister and Toboosa soils.

The main concern of management is maintaining soil structure and fertility. This soil is high in content of clay, and structure can be damaged if the soil is grazed or tilled when wet. The use of high-residue crops helps to maintain soil structure, adds organic matter, and increases the water intake rate. Drainage is needed in some areas to remove ponded water.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIw–1; Hardland range site; pasture and hay group 7A; tree and shrub group 6.

St. Paul Series

The St. Paul series consists of deep, well-drained, nearly level or very gently sloping soils on uplands. These soils formed in loess, alluvium, or residuum from redbeds under a cover of native grasses.

In a representative profile the surface layer is dark-brown silt loam about 9 inches thick. The upper 7 inches of the subsoil is dark-brown silty clay loam, the middle 26 inches is reddish-brown silty clay loam, and the lower 13 inches is yellowish-red silty clay loam. The underlying material is red silty clay loam to a depth of 65 inches.

Permeability is moderately slow. The available water capacity is high.

Representative profile of St. Paul silt loam, 1 to 3 percent slopes, 200 feet south and 400 feet west of the northeast corner of sec. 18, T. 7 N., R. 18 W.:

Ap—0 to 9 inches, dark-brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B1—9 to 16 inches, dark-brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; strong, medium, granular structure; slightly hard, friable; neutral; clear, smooth boundary.

B21t—16 to 30 inches, reddish-brown (5YR 4/3) silty clay loam, dark reddish brown (5YR 3/3) moist; moderate, fine, subangular blocky structure; hard, firm; nearly continuous clay films on faces of peds; mildly alkaline; clear, smooth boundary.

B22t—30 to 42 inches, reddish-brown (5YR 4/4) silty clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium, subangular blocky structure; very hard, very firm; nearly continuous clay films on faces of peds; few fine concretions of calcium carbonate, few soft bodies of lime; calcareous; moderately alkaline; gradual, smooth boundary.

B3—42 to 55 inches, yellowish-red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; weak, fine, subangular blocky structure; hard, firm; patchy clay films on faces of peds; many fine concretions of calcium carbonate, few soft bodies of lime; calcareous; moderately alkaline; gradual, smooth boundary.

C—55 to 65 inches, red (2.5YR 5/6) silty clay loam, red (2.5YR 4/6) moist; massive; hard, firm; few fine concretions of calcium carbonate; calcareous; moderately alkaline.

Depth to soft powdery lime ranges from 30 to 45 inches. The A horizon is reddish brown or dark brown. Reaction is neutral or mildly alkaline.

The B1 horizon is similar to the A horizon in color and reaction. It is silt loam or silty clay loam. The B2t horizon is dark-brown, brown, reddish-brown, reddish-gray, or dark reddish-gray clay loam or silty clay loam. Reaction is mildly alkaline or moderately alkaline. The B3 horizon is brown, dark-brown, strong-brown, reddish-brown, yellowish-red, or red loam, silt loam, clay loam, or silty clay loam. It is mildly alkaline or moderately alkaline.

The C horizon is reddish-brown, light reddish-brown, red, or yellowish-red loam, silt loam, clay loam, or silty clay loam. Reaction is mildly alkaline or moderately alkaline.

SaA—St. Paul silt loam, 0 to 1 percent slopes. This nearly level soil is on uplands. Included in mapping are spots of Hollister and Carey soils.

The main concern of management is maintaining soil structure. Grazing or tilling the soil when it is wet breaks down the soil structure and reduces the water intake rate. Excessive tillage pulverizes the surface layer and makes it susceptible to soil blowing. Even though erosion is not a hazard, contour tillage or planting crops across the slope helps to reduce runoff.

This soil is used for cultivated crops, such as wheat, grain sorghum, cotton, and alfalfa. Most of the crops generally grown on this soil produce large amounts of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Small areas are used for tame pasture. Capability unit IIc–1; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

SaB—St. Paul silt loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are about 10 percent areas of Carey soils and spots of Hollister soils.

The main concerns of management are maintaining soil structure and fertility and controlling erosion. Some important management practices are stubble mulching, contour farming, using crop residue and adding plant nutrients as needed, growing cover crops (fig. 7), keeping tillage to a minimum and tilling at variable depths, and installing terraces that have protected outlets.

This soil is used for cultivated crops, such as wheat, grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture. Capability unit IIe–1; Loamy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

SbA—St. Paul-Hinkle complex, 0 to 1 percent slopes. This complex consists of nearly level soils on uplands. It is about 75 percent St. Paul silt loam and 15 percent Hinkle silt loam. The two soils are so intermingled that it is not practical to map them separately. The St. Paul soil in this complex has a profile that is similar to the one described as representative of the St. Paul series but has lime at a depth of 23 to 28 inches. Included in mapping are 10 percent areas of Natrustalfs and spots of Carey, Hollister, and Tillman soils.

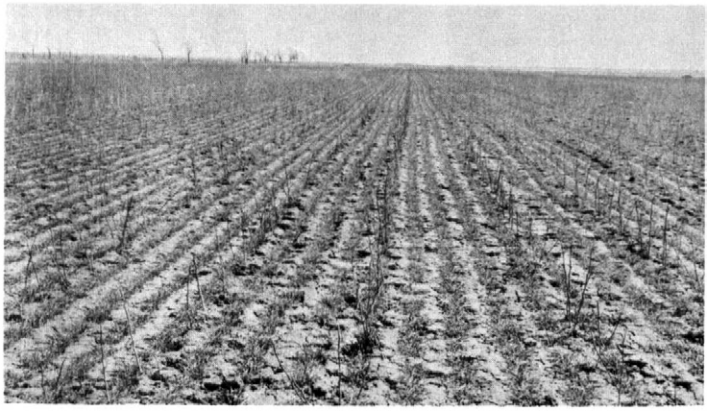


Figure 7.—A cover crop of small grain growing between the rows of residue cottonstalks in an area of St. Paul silt loam, 1 to 3 percent slopes. Such management helps reduce the hazard of erosion.

The main concerns of management are maintaining soil structure, reducing surface crusting, reducing salinity, and controlling erosion. Some important management practices are returning all crop residue to the soil, stubble mulching, adding plant nutrients as needed, keeping tillage to a minimum and tilling at the proper time and to a shallow depth, and establishing perennial vegetation in natural drainageways. Salt concentration reduces the water intake rate, causes surface crusting, and damages soil structure. These effects make the soil droughty and retard the emergence of seedlings. Chemical amendments, such as gypsum, may be beneficial.

These soils are used mainly for cultivated crops, such as wheat, grain sorghum, and cotton. Some areas are used for tame pasture. Both parts in capability unit IVs–1; St. Paul part in Loamy Prairie range site, Hinkle part in Slickspot range site; St. Paul part in pasture and hay group 8A, Hinkle part in pasture and hay group 8D; both parts in tree and shrub group 5.

Shellabarger Series

The Shellabarger series consists of deep, well-drained, gently sloping to strongly sloping soils on uplands. These soils formed in old alluvial sediment under a cover of native grasses.

In a representative profile the surface layer is reddish-brown fine sandy loam about 12 inches thick. The upper 8 inches of the subsoil is reddish-brown fine sandy loam, the middle 16 inches is reddish-brown sandy clay loam, and the lower 12 inches is yellowish-red sandy clay loam. The underlying material is yellowish-red sandy loam to a depth of 65 inches.

Permeability is moderate. The available water capacity is medium.

Representative profile of Shellabarger fine sandy loam, 3 to 5 percent slopes, 700 feet north and 300 feet west of the southeast corner of sec. 19, T. 6 N., R. 15 W.:

A1—0 to 12 inches, reddish-brown (5YR 4/3) fine sandy loam, dark reddish brown (5YR 3/3) moist; moderate, medium, granular structure; soft, very friable; many fine roots; many fine pores; many worm casts; slightly acid; clear, smooth boundary.

B1—12 to 20 inches, reddish-brown (5YR 5/3) fine sandy loam, dark reddish brown (5YR 3/3) moist; strong, medium, granular structure; slightly hard, friable; many fine roots; many fine pores; many worm casts; neutral; clear, smooth boundary.

B21t—20 to 36 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; strong, medium, subangular blocky structure; slightly hard, friable; many fine pores; common worm casts; patchy clay films on faces of peds; calcareous; moderately alkaline; gradual, smooth boundary.

B22t—36 to 48 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate fine, subangular blocky structure; slightly hard, friable; many fine pores; nearly continuous clay films on faces of peds; common worm casts; few films of calcium carbonate below a depth of about 40 inches; calcareous; mildly alkaline; gradual, smooth boundary.

C—48 to 65 inches, yellowish-red (5YR 5/6) sandy loam, yellowish red (5YR 4/6) moist; massive; slightly hard,

friable; few pores and worm casts; few films of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 36 to 60 inches in thickness. Depth to visible calcium carbonate is more than 34 inches. The dark-colored surface layer is 10 to 20 inches thick. In places the soil is as much as 10 percent pebbles as much as 1 inch in diameter throughout.

The A horizon is reddish brown, dark reddish gray, brown, or dark brown. Reaction is medium acid or slightly acid.

The B1 horizon is reddish brown or dark brown. Reaction is slightly acid or neutral. The B2t horizon is yellowish red or reddish brown.

The C horizon is yellowish-red, reddish-brown, or red sandy loam or sandy clay loam. Reaction is mildly alkaline or moderately alkaline.

Shellabarger soils in Kiowa County are outside the range for the series in not having visible carbonates above a depth of 36 inches but being slightly effervescent with acid at a depth of 20 to 36 inches. Also, in places there are fragments of limestone of gravel and coarse sand size in the lower part of the B horizon, and reaction is moderately alkaline in the B horizon. These differences do not alter the use, behavior, or management of the soils.

ShC—Shellabarger fine sandy loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. Included in mapping are spots of Lawton soils and about 5 percent areas of soils that are similar to this Shellabarger soil but have a dark-colored surface layer that is less than 10 inches thick or have a lighter colored surface layer.

The main concerns of management are controlling soil blowing and erosion and maintaining fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, stubble mulching, growing cover crops, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIe–3; Sandy Prairie range site; pasture and hay group 8A; tree and shrub group 5.

Somervell Series

The Somervell series consists of moderately deep, well-drained, gently sloping to moderately steep soils on uplands. These soils formed in material weathered from limestone under a cover of native grasses and widely spaced trees.

In a representative profile the surface layer is dark-brown cobbly loam about 11 inches thick. The subsoil is light yellowish-brown cobbly clay loam. Limestone bedrock is at a depth of about 34 inches.

Permeability is moderate. The available water capacity is medium.

Representative profile of Somervell cobbly loam, 3 to 20 percent slopes, 400 feet south and 400 feet west of the northeast corner of sec. 14, T. 6 N., R. 16 W.:

A1—0 to 11 inches, dark-brown (10YR 4/3) cobbly loam, dark brown (10YR 3/3) moist; strong, fine, granular structure; slightly hard, friable, about 70 percent, by volume, limestone fragments of gravel and cobble size; calcareous; moderately alkaline; clear, smooth boundary.

B2—11 to 34 inches, light yellowish-brown (2.5Y 6/4) cobbly clay loam, light olive brown (2.5Y 5/4) moist; strong, fine, subangular blocky structure; hard, firm; about 80 percent, by volume, limestone fragments of gravel and cobble size; calcareous; moderately alkaline; clear, wavy boundary.

R—34 to 38 inches, limestone.

The solum ranges from 24 to 40 inches in thickness. It is 70 to 85 percent limestone fragments of gravel and cobble size. The A horizon is dark grayish brown or dark brown. The B2 horizon is light yellowish brown.

SoF—Somervell cobbly loam, 3 to 20 percent slopes. This gently sloping to moderately steep soil is on uplands. Included in mapping are spots of Talpa soils and Rock outcrop.

This soil is used for range. It is not suited to cultivation. Capability unit VIIs–1; Limestone Ridge range site; pasture and hay group not assigned; tree and shrub group 9.

Talpa Series

The Talpa series consists of very shallow and shallow, well-drained, very gently sloping to moderately steep soils on uplands. These soils formed in material weathered from limestone under a cover of native grasses.

In a representative profile the surface layer is brown loam. Limestone is at a depth of about 9 inches.

Permeability is moderate. The available water capacity is low.

Representative profile of Talpa loam, 1 to 5 percent slopes, 1,000 feet south and 1,000 feet east of the northwest corner of sec. 2, T. 7 N., R. 17 W.:

A1—0 to 9 inches, brown (7.5YR 5/2) loam, dark brown (7.5YR 3/2) moist; moderate, medium, granular structure; slightly hard, friable; many fine pores; many worm casts; calcareous; moderately alkaline; clear, smooth boundary.

R&Cca—9 to 14 inches, indurated limestone that has strongly cemented calcium carbonate on the surface and powdery lime in the cracks and crevices; abrupt, smooth boundary.

R—14 to 20 inches, indurated limestone.

The solum ranges from 5 to 14 inches in thickness. The A horizon is dark grayish brown, very dark grayish brown, brown, or dark brown.

TaC—Talpa loam, 1 to 5 percent slopes. This very gently sloping or gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are spots of Gotebo soils and small areas of Rock outcrop and soil material less than 3 inches thick.

This soil is used for range. Capability unit VIs–1; Shallow Prairie range site; pasture and hay group 14A; tree and shrub group 9.

TbF—Talpa-Rock outcrop complex, 8 to 50 percent slopes. This complex consists of strongly sloping to moderately steep soils and strongly sloping to very steep Rock outcrop on uplands. It is about 60 percent Talpa loam and 40 percent Rock outcrop and soil material less than 3 inches thick. The Talpa soil and Rock outcrop are so intermingled that it is impractical to map them separately. Rock outcrop consists of limestone ledges tilted at an angle of about 25 degrees and exposed in a northwest-southeast direction. The exposed ledges are 6 inches to 2 feet above the Talpa soils. The Talpa soil occurs in bands, 1 foot to 10 feet wide, between the outcrops. Fragments of limestone

2 to 6 inches in diameter are scattered on the surface of the Talpa soil in most areas.

This complex is used only for range. Both parts in capability unit VIIs–6; Talpa part in Edgerock range site, Rock outcrop part not assigned to a range site; pasture and hay group not assigned; both parts in tree and shrub group 9.

Tillman Series

The Tillman series consists of deep, well-drained, very gently sloping or gently sloping soils on uplands. These soils formed in old clayey alluvial sediment under a cover of native grasses and widely spaced trees.

In a representative profile the surface layer is dark-brown clay loam about 11 inches thick. The upper 25 inches of the subsoil is reddish-brown clay loam, the middle 29 inches is red clay loam, and the lower 30 inches is a mixture of red clay and reddish-yellow silty clay.

Permeability is slow. The available water capacity is high.

Representative profile of Tillman clay loam, 1 to 3 percent slopes, 500 feet west and 1,100 feet north of the southeast corner of sec. 32, T. 6 N., R. 17 W.:

A1—0 to 11 inches, dark-brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, fine, granular structure; hard, friable; many fine and medium roots; neutral; clear, smooth boundary.

B21t—11 to 17 inches, reddish-brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/2) moist; moderate, fine, subangular blocky structure; hard, friable; common fine and medium roots; mildly alkaline; clear, smooth boundary.

B22t—17 to 26 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate, medium, prismatic structure parting to moderate, medium, blocky; extremely hard, very firm; few fine roots; few shiny surfaces on faces of peds; few slickensides; moderately alkaline; clear, wavy boundary.

B23t—26 to 36 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate, coarse, prismatic structure parting to moderate, medium, blocky; extremely hard, very firm; few fine roots; few shiny surfaces on faces of peds; few slickensides; few soft masses of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—36 to 59 inches, red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; moderate, medium and coarse, subangular blocky structure; extremely hard, very firm; few fine roots; few shiny surfaces on faces of peds; about 4 percent soft masses of calcium carbonate; few concretions; calcareous; moderately alkaline; gradual, wavy boundary.

B25tca—59 to 65 inches, red (2.5YR 5/6) clay loam, red (2.5YR 4/6) moist; moderate, medium and coarse, subangular blocky structure; extremely hard, very firm; very firm; few fine roots; few shiny surfaces on faces of peds; about 4 percent soft masses of calcium carbonate; few concretions; calcareous; moderately alkaline; gradual, wavy boundary.

IIB3&C—65 to 95 inches, B3 part is red (10YR 4/6) clay, dark red (10R 3/6) moist, and has moderate, medium, blocky structure; C part is reddish-yellow (5YR 7/6) silty clay, reddish yellow (5YR 6/6) moist, and is massive; extremely hard, very firm; many fragments of greenish-gray shale; few seams filled with calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. Secondary lime is between depths of 19 and 28 inches.

The A and B21t horizons are dark reddish gray, reddish brown, or dark brown. These horizons range from 12 to 19 inches in thickness. The B2t horizon below a depth of 12 to 19 inches is reddish-brown, dark reddish-brown, red, dark-red, or yellowish-red clay loam or clay. The IIB3 and C horizons are weakly consolidated shale in shades of red, brown, gray, or green. They are clay loam, clay, and shaly clay.

TcB—Tillman clay loam, 1 to 3 percent slopes. This very gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are about 25 percent areas of Hollister soils and 5 percent areas of Lawton soils.

The main concerns of management are controlling erosion and maintaining soil structure and fertility. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, pasture, and range. Capability unit IIe–3; Hardland range site; pasture and hay group 8A; tree and shrub group 6.

TcC—Tillman clay loam, 3 to 5 percent slopes. This gently sloping soil is on uplands. Included in mapping are areas of Hollister soils that make up about 15 percent of the acreage.

The main concerns of management are maintaining soil structure, increasing the water intake rate, and controlling erosion. Grazing or tilling when the soil is wet breaks down the soil structure and reduces the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets.

This soil is used for wheat, grain sorghum, cotton, and range. Capability unit IIIe–1; Hardland range site; pasture and hay group 8A; tree and shrub group 6.

TdB—Tillman-Hinkle complex, 1 to 3 percent slopes. This complex consists of very gently sloping soils on uplands. It is about 65 percent Tillman clay loam, 25 percent Hinkle silt loam, and about 5 percent each Natrustalfs and Miller soils, saline. The Tillman and Hinkle soils are so intermingled that it is impractical to map them separately. The Tillman soil in this complex has a profile similar to the one described as representative of the Tillman series, but the subsoil is clay.

The main concerns of management are maintaining soil structure, reducing surface crusting, reducing sodium, and decreasing the hazard of erosion. Some important management practices are returning all crop residue to the soil, stubble mulching, adding plant nutrients as needed, keeping tillage to a minimum and tilling at the proper time and to a shallow depth, and establishing perennial vegetation in natural drainageways. Sodium concentrations reduce the water intake rate, cause surface crusting, and damage soil structure. These effects make the soil droughty and retard the emergence of seedlings. Chemical amendments, such as gypsum, may be beneficial.

These soils are used mainly for wheat or grain sorghum. Small areas are used for tame pasture. Both parts in capability unit IVs–1; Tillman part in Hardland range site, Hinkle part in Slickspot range site;

Tillman part in pasture and hay group 8A, Hinkle part in pasture and hay group 8D; both parts in tree and shrub group 6.

ToC2—Tillman-Vernon complex, 2 to 5 percent slopes, eroded. This complex consists of very gently sloping or gently sloping, eroded soils on uplands. It is about 50 percent Tillman soils; 40 percent Vernon soils; 5 percent soils that are similar to Vernon soils but have a surface layer and subsoil less than 20 inches thick; and spots of Carey and Hollister soils. The Tillman and Vernon soils are so intermingled that it is impractical to map them separately. The Tillman soil in this complex has a profile similar to the one described as representative of the Tillman series, but the surface layer is reddish-brown clay loam and has been thinned by erosion to about 6 inches. The Vernon soil has a profile similar to the one described as representative of the Vernon series, but the surface layer is clay loam or silty clay, past erosion has exposed the subsoil on about 25 percent of the area, and the present plow layer is a mixture of the original surface layer and material from the subsoil. Small rills and gullies are common in most areas.

The main concerns of management are maintaining soil structure, reducing the hazard of water erosion, and increasing the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at variable depths, tilling on the contour, and installing terraces that have protected outlets. These practices tend to maintain soil structure, reduce the hazard of erosion, prevent crusting, and increase the water intake rate.

These soils are used mainly for wheat and grain sorghum. Small areas are used for tame pasture. Both parts in capability unit IVe–1; Tillman part in Hardland range site, Vernon part in Red Clay Prairie range site; both parts in pasture and hay group 8A; both parts in tree and shrub group 6.

Tivoli Series

The Tivoli series consists of deep, excessively drained, gently sloping to moderately steep soils on uplands. These soils formed in sandy eolian material under a cover of native grass.

In a representative profile the surface layer is light-brown loamy fine sand about 6 inches thick. The underlying material is reddish-yellow fine sand to a depth of 60 inches.

Permeability is rapid. The available water capacity is low.

Representative profile of Tivoli loamy fine sand in an area of Tivoli-Pratt complex, 3 to 15 percent slopes, 1,600 feet west and 500 feet south of the northwest corner of the SE¼ sec. 33, T. 6 N., R. 20 W.:

A1—0 to 6 inches, light-brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 5/4) moist; single grained; loose, very friable; many fine roots; neutral; clear, smooth boundary.

C—6 to 60 inches, reddish-yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) moist; single grained; loose; few fine roots, number decreasing with increasing depth; neutral.

The A horizon is reddish brown, light reddish brown, brown, or light brown. Reaction is slightly acid to mildly alkaline.

The C horizon is reddish brown, light brown, strong brown, reddish yellow, or yellowish brown. Reaction is slightly acid to mildly alkaline in the upper part and neutral to moderately alkaline in the lower part.

TpF—Tivoli-Pratt complex, 3 to 15 percent slopes. This complex consists of gently sloping to moderately steep soils on uplands. It is about 50 percent Tivoli loamy fine sand and 35 percent Pratt loamy fine sand. The two soils are so intermingled that it is not practical to map them separately. Included in mapping are about 10 percent areas of Grandfield soils and 5 percent areas of Devol soils.

These soils are used for range. Both parts in capability unit VIe–2; Tivoli part in Dune range site, Pratt part in Deep Sand range site; both parts in pasture and hay group 9B; both parts in tree and shrub group 8.

Tobosa Series

The Tobosa series consists of deep, well-drained, nearly level soils on uplands. These soils formed in clayey sediment under a cover of native grasses and widely spaced trees.

In a representative profile the surface layer is dark grayish-brown clay about 9 inches thick. The next layer is about 15 inches of grayish-brown clay. The subsoil is brown clay about 20 inches thick. The underlying material is reddish-yellow clay to a depth of 60 inches.

Permeability is very slow. The available water capacity is high.

Representative profile of Tobosa clay, 0 to 1 percent slopes, 300 feet east and 200 feet north of the southwest corner of the NW¼ sec. 35, T. 6 N., R. 15 W.:

AP—0 to 4 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) moist; moderate, fine and very fine, granular structure; hard, friable; calcareous; moderately alkaline; clear, smooth boundary.

A11—4 to 9 inches, dark grayish-brown (10YR 4/2) clay, very dark brown (10YR 2/2) moist; weak, fine, subangular blocky structure; very hard, very firm; calcareous; moderately alkaline; gradual, wavy boundary.

A12—9 to 24 inches, grayish-brown (10YR 5/2) clay, very dark grayish brown (10YR 3/2) moist; weak, fine, subangular blocky structure; very hard, very firm; few wedge-shaped aggregates; few intersecting slickensides; common streaks of dark-colored material from A11 horizon; few brownish concretions; many concretions of calcium carbonate, few soft bodies of calcium carbonate; calcareous; moderately alkaline; gradual, wavy boundary.

AC—24 to 44 inches, brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; weak, fine, subangular blocky structures that form parallelepipeds; very hard, very firm; common grooved intersecting slickensides; many concretions of calcium carbonate; calcareous moderately alkaline; gradual, wavy boundary.

C—44 to 60 inches, reddish-yellow (7.5YR 6/6) clay, strong brown (7.5YR 5/6) moist; massive; very hard, very firm; common streaks of darker colored material in upper part; calcareous; moderately alkaline.

The solum ranges from 40 inches to more than 60 inches in thickness. Undisturbed areas have a microrelief of knolls 4 to 12 inches higher than the depressions. The distance between the center of the knoll and the center of the depression is 7 to 10 feet.

The A horizon is dark grayish brown (10YR 4/2) or very dark grayish brown (10YR 3/2). The AC horizon is dark-brown (10YR 4/3) or brown (10YR 5/3) silty clay or clay that has few to many soft masses of carbonates and concretions. The C horizon is reddish-yellow (7.5YR 6/6, 7/6), pink (7.5YR 7/4), or pinkish-gray (7.5YR 6/2) clay or silty clay.

TsA—Tobosa clay, 0 to 1 percent slopes. This nearly level soil is on uplands. Included in mapping are spots of Hollister and Roscoe soils.

The main concerns of management are maintaining soil structure (fig. 8), reducing surface crusting, and increasing the water intake rate. This soil is high in content of clay, and the structure is damaged and the water intake rate decreased if the soil is grazed or tilled when wet. Some important management practices are returning all crop residue to the soil and keeping tillage to a minimum and tilling at variable depths. These practices help to maintain soil structure and increase the water intake rate.

This soil is used for wheat, grain sorghum, cotton, and tame pasture. Capability unit IIIs–2; Hardland range site; pasture and hay group 7A; tree and shrub group 6.

Vernon Series

The Vernon series consists of moderately deep, well-drained, very gently sloping to strongly sloping soils on uplands. These soils formed in clayey material weathered from shale and clay under a cover of native grasses.

Figure 8.—Wide cracks in the surface layer of Tobosa clay, 0 to 1 percent slopes. Cracking is caused by shrinking and swelling of the clay in this soil.

In a representative profile the surface layer is reddish-brown clay loam about 7 inches thick. The subsoil is red silty clay about 22 inches thick. The underlying material is red shaly clay to a depth of 60 inches.

Permeability is very slow. The available water capacity is high.

Representative profile of Vernon clay loam, 2 to 5 percent slopes, 1,900 feet north and 300 feet west of the southeast corner of sec. 26, T. 6 N., R. 17 W.:

AP—0 to 7 inches, reddish-brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; moderate, medium, granular structure; very hard, very firm; calcareous; moderately alkaline; clear, smooth boundary.

B2—7 to 29 inches, red (2.5YR 4/6) silty clay, dark red (2.5YR 3/6) moist; moderate, fine, subangular blocky structure; extremely hard, extremely firm; calcareous; moderately alkaline; gradual, smooth boundary.

C—29 to 60 inches, red (2.5YR 4/6) shaly clay, dark red (2.5YR 3/6) moist; massive; extremely hard, extremely firm; calcareous; moderately alkaline.

The solum ranges from 20 to 30 inches in thickness. The A horizon is reddish-brown, yellowish-red, or red clay loam or clay. The B2 horizon is red or yellowish-red silty clay or clay that is 40 to 50 percent clay. The C horizon is red or yellowish red.

VeC—Vernon clay loam, 2 to 5 percent slopes. This very gently sloping or gently sloping soil is on uplands. It has the profile described as representative of the series. Included in mapping are about 5 percent areas of Tillman soils.

The main concerns of management are maintaining soil structure, controlling erosion, and increasing the water intake rate. Some important management practices are returning all crop residue to the soil and adding plant nutrients as needed, keeping tillage to a minimum and tilling at the proper time and at variable depths, tilling on the contour, and installing terraces that have protected outlets. These practices tend to maintain soil structure, reduce the hazard of erosion, prevent crusting, and increase the water intake rate.

This soil is used mainly for range. Small areas are used for wheat and grain sorghum. Capability unit IVe–1; Red Clay Prairie range site; pasture and hay group 8A; tree and shrub group 6.

VmE—Vernon-Mangum complex, 0 to 12 percent slopes. This complex is about 40 percent Vernon clay loam, 30 percent Mangum silty clay, 5 percent Rock outcrop, and 25 percent soils that are similar to this Vernon soil but are underlain by bedrock at a depth of less than 20 inches. The Vernon and Mangum soils are so intermingled that it is not practical to map them separately. The Vernon soil in this complex is very gently sloping to strongly sloping and is on uplands, and the Mangum soil is nearly level and is on flood plains that are subject to flooding.

These soils are used mainly for range. Both parts in capability unit VIe–6; Vernon part in Red Clay Prairie range site, Mangum part in Heavy Bottomland range site; Vernon part in pasture and hay group 8A, Mangum part in pasture and hay group 1A; both parts in tree and shrub group 9.

VrE—Vernon-Rock outcrop complex, 2 to 12 percent slopes. This complex consists of very gently sloping to strongly sloping soils on uplands. It is about 50 percent Vernon clay, 40 percent Rock outcrop, and 10 percent soils that are similar to this Vernon soil but are underlain by clayey shale at a depth of less than 20 inches. The Vernon soil and Rock outcrop are so intermingled that it is not practical to map them separately. The Vernon soil in this complex has a profile similar to the one described as representative of the Vernon series, but the surface layer and subsoil are clay. The Rock outcrop part of the complex consists of exposed, horizontally bedded clay and shale. Rounded pebbles are common on the surface.

These soils are used only for range. Both parts in capability unit VIIs–4; Vernon part in Red Clay Prairie range site, Rock outcrop part in Eroded Red Clay range site; pasture and hay group not assigned; both parts in tree and shrub group 9.

VsE—Vernon soils, 5 to 12 percent slopes. These sloping or strongly sloping soils are on uplands. They have a profile similar to the one described as representative of the series, but in many areas the surface layer is clay and in 30 percent of the area clay or shale is at a depth of less than 20 inches. Included in mapping, and making up about 5 percent each of the acreage, are areas of Tillman and Mangum soils.

These soils are used for range. Capability unit VIe–5; Red Clay Prairie range site; pasture and hay group 8A; tree and shrub group 9.

Yahola Series

The Yahola series consists of deep, well-drained, nearly level soils on flood plains. These soils formed in loamy alluvial sediment under a cover of native grasses and an overstory of trees.

In a representative profile the surface layer is reddish-brown fine sandy loam about 14 inches thick. The upper 26 inches of the underlying material is reddish-brown fine sandy loam, the middle 19 inches is reddish-brown loam, and the lower 13 inches is yellowish-red fine sandy loam.

Permeability is moderately rapid. The available water capacity is medium.

Representative profile of Yahola fine sandy loam, 1,400 feet east and 1,500 feet north of the southwest corner of sec. 5, T. 7 N., R. 14 W.:

A1—0 to 14 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, fine, granular structure; soft, very friable; common worm casts; calcareous; moderately alkaline; clear, smooth boundary.

C1—14 to 40 inches, reddish-brown (5YR 5/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; massive; slightly hard, very friable; thin strata of loamy fine sand and silt loam in lower part; calcareous; moderately alkaline; clear, smooth boundary.

C2—40 to 59 inches, reddish-brown (5YR 5/3) loam, dark reddish brown (5YR 3/3) moist; massive; slightly hard, friable; calcareous; moderately alkaline; gradual, smooth boundary.

C3—59 to 72 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; massive; soft, very friable; thin strata of loamy fine sand; calcareous; moderately alkaline.

The A and C horizons are moderately alkaline and calcareous throughout. The A horizon is reddish brown. The C horizon is reddish brown, light reddish brown, pink, yellowish red, or brown. The C1 horizon is fine sandy loam or loam. The C2 and C3 horizons are fine sandy loam and loam. Thin strata of coarser textured or finer textured material occur throughout the C horizon.

Ya—Yahola fine sandy loam. This nearly level soil is on flood plains that are subject to occasional flooding. Slopes are 0 to 1 percent. Included in mapping are spots of Cyril and Lincoln soils.

The main concerns of management are maintaining soil structure and protecting the soils from flooding. Flooding can be reduced by watershed protection projects and detention dams. Other important management practices are growing cover crops and keeping tillage to a minimum and tilling at variable depths.

This soil is used for wheat, grain sorghum, cotton, and alfalfa. Small areas are used for tame pasture. Most of the crops grown on this soil produce large amounts of crop residue and can be grown year after year if the residue is returned to the soil and plant nutrients are added. Capability unit IIw–1; Loamy Bottomland range site; pasture and hay group 2A; tree and shrub group 3.

Use and Management of the Soils

This section explains the system of capability classification used by the Soil Conservation Service and shows estimated yields of principal crops grown in the county. It also contains information about management of the soils for cultivated crops and for tame pasture and hay and use of the soils for range, trees, wildlife habitat, recreation, and engineering.

Management of the Soils for Cultivated Crops[2]

Cultivated soils in Kiowa County need management that conserves moisture, reduces the hazard of erosion, maintains soil structure and fertility, supplies organic matter, and preserves good tilth. Some of the management practices commonly needed in the county are discussed below. Suggested combinations of practices for specific soils are given in the section "Descriptions of the Soils."

The information in this section can be used along with that in the descriptions of the mapping units to help the farmer and rancher to select appropriate practices for specific soils. Most good management practices accomplish more than one purpose and can be used on nearly all of the cropland in the county.

Some of the management practices applicable on the soils in this county are briefly described in the following paragraphs.

Minimum tillage.—Soils that are used for crops must be tilled to prepare a seedbed, to reduce weeds, and to provide a suitable place for the growth of plant roots. Excessive tillage breaks down soil structure and speeds the decomposition of organic matter. The soils then tend to puddle and crust at the surface and to take in

[2] M. D. GAMBLE, conservation agronomist, Soil Conservation Service, helped to prepare this section.

less water and air, which results in less moisture being stored for plant growth.

Minimum tillage is accomplished by reducing the number of operations in preparing the seedbed, planting, and cultivating; using herbicides in place of cultivation for reducing weeds; and using a long-term cropping system that includes perennial grasses or legumes.

Crop residue management.—Crop residue (fig. 9) can be used to help to maintain soil structure and fertility and control erosion. The crop residue is left on the surface or worked partly into the surface layer. Crop residue supplies organic matter, or humus, which improves soil structure and soil tilth, reduces the hazard of erosion, and helps to prevent crusting. Soil-maintaining crops, such as wheat, produce a large amount of residue. Additional plant nutrients should be added to maintain soil fertility.

Control of erosion.—The increase in crop yields in recent years indicates that effective measures for reducing erosion have been applied. Suitable practices for helping to reduce the hazard of erosion are growing a winter cover crop, stripcropping, using a cropping system that returns crop residue to the soil, stubble mulching, terracing, farming on the contour, installing grassed waterways, and applying plant nutrients.

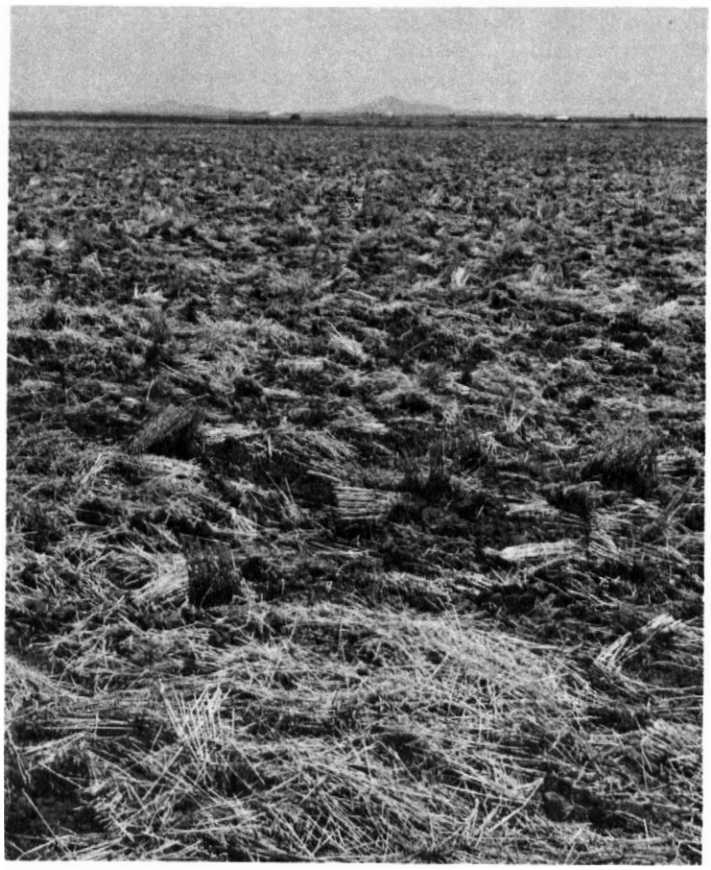


Figure 9.—Crop residue left on the surface of Hollister silty clay loam, 0 to 1 percent slopes.

Practices that reduce damage from insects and plant diseases are also needed.

Management for tame pasture.—Tame pasture is an important source of forage for livestock. Tame pasture combined with supplemental pasture and native range provide year-round grazing for livestock.

Bermudagrass is best suited to the flood-plain soils, such as the Yahola fine sandy loam soils. Weeping lovegrass is best suited to the deep, fine sandy loam soils of the county.

Under good grazing management production can be maintained and the hazard of erosion reduced.

Capability grouping

Some readers, particularly those who farm on a large scale, may find it practical to use and manage alike some of the different kinds of soil on their farm. These readers can make good use of the capability classification system, a grouping that shows, in a general way, the suitability of soils for most kinds of farming.

The grouping is based on permanent limitations of soils when used for field crops, the risk of damage when they are farmed, and the way the soils respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels: the class, the subclass, and the unit. The broadest grouping, the capability class, is designated by Roman numerals I to VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when they are used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms that are so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products.

The subclass indicates major kinds of limitations within the classes. Within most of the classes there are as many as four subclasses. The subclasses are indicated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral; for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* means that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used only in some parts of the United States, indicates that the chief limitation is climate that is too cold or too dry. In class I there are no subclasses, because the soils of this class have few or no limitations. Class V can contain, at the most, only subclasses

w, *s*, and *c*, because the soils are subject to little or no erosion but have other limitations that confine their use largely to pasture, range, or wildlife habitat.

Subclasses are further divided into groups called capability units. These are groups of soils that are so much alike that they are suited to the same crops and pasture plants, require about the same management, and have generally similar productivity and other response to management. Capability units are generally identified by numbers assigned locally; for example, IIe–1 or IIIs–2.

The eight classes in the capability system and the subclasses and units in Kiowa County are described in the list that follows. The unit designation for each soil mapped in the county is shown in the Guide to Mapping Units.

Class I. Soils that have few limitations that restrict their use (no subclasses).

Unit I–1. Deep, nearly level, well drained and moderately well drained loam and silty clay loam soils that have a loamy subsoil; on flood plains or terraces.

Class II. Soils that have moderate limitations that reduce the choice of plants or require moderate conservation practices.

Subclass IIe. Soils subject to moderate erosion unless protected.

Unit IIe–1. Deep, very gently sloping, well-drained loam and silt loam soils that have a loamy subsoil; on uplands.

Unit IIe–2. Deep, nearly level, well-drained fine sandy loam soils that have a loamy subsoil; on uplands.

Unit IIe–3. Deep, very gently sloping, well-drained clay loams or silty clay loam soils that have a loamy or clayey subsoil; on uplands.

Unit IIe–4. Deep, nearly level or very gently sloping moderately well drained loamy fine sand soils that have a loamy subsoil; on uplands.

Subclass IIw. Soils moderately limited because of excess water.

Unit IIw–1. Deep, nearly level, well-drained fine sandy loam soils that are underlain by loamy material; on flood plains.

Unit IIw–2. Deep, nearly level, well-drained loams or silty clay loam soils that have a loamy subsoil; on flood plains.

Subclass IIs. Soils moderately limited because of very slow permeability.

Unit IIs–1. Deep, nearly level, moderately well drained silt loam soils that have a loamy or clayey subsoil; on uplands.

Subclass IIc. Soils moderately limited because of climate that is too dry.

Unit IIc–1. Deep, nearly level, well-drained silt loams or silty clay loam soils that have a loamy or clayey subsoil; on uplands.

Class III. Soils that have severe limitations that reduce the choice of plants or require special conservation practices, or both.

Subclass IIIe. Soils subject to severe erosion if they are cultivated and not protected.

Unit IIIe–1. Deep, gently sloping or very gently sloping, well-drained clay loam or silty clay loam soils that have a loamy or clayey subsoil; on uplands.

Unit IIIe–2. Deep, gently sloping, well-drained loams or silt loam soils that have a loamy subsoil; on uplands.

Unit IIIe–3. Deep and moderately deep, very gently sloping or gently sloping, well-drained fine sandy loam soils that have a loamy subsoil; on uplands.

Unit IIIe–4. Deep, very gently sloping, well-drained fine sandy loam soils that have a loamy subsoil; on uplands.

Unit IIIe–5. Deep, gently sloping, well-drained fine sandy loam soils that have a loamy subsoil; on uplands.

Unit IIIe–6. Deep, nearly level or very gently sloping, well-drained loamy fine sand soils that have a loamy or sandy subsoil; on uplands.

Subclass IIIs. Soils severely limited because of soil features.

Unit IIIs–2. Deep, nearly level, well-drained clay soils that are underlain by clayey material; on uplands.

Subclass IIIw. Soils severely limited because of excess water.

Unit IIIw–1. Deep, nearly level, moderately well drained clay soils that are underlain by clayey material; on uplands.

Unit IIIw–2. Deep, nearly level, moderately well drained clay soils that have a loamy or clayey subsoil; on flood plains.

Class IV. Soils that have very severe limitations that reduce the choice of plants or require very careful management, or both.

Subclass IVe. Soils subject to very severe erosion if they are cultivated and not protected.

Unit IVe–1. Deep or moderately deep, very gently sloping or gently sloping, well-drained clay loam, silty clay loam, or silty clay soils that have a loamy or clayey subsoil; on uplands.

Unit IVe–2. Deep, sloping, well-drained loam soils that have a loamy subsoil; on uplands.

Unit IVe–3. Deep, sloping, well-drained fine sandy loam soils that have a loamy subsoil; on uplands.

Unit IVe–4. Eroded, deep, very gently sloping or gently sloping, well-drained loam or silt loam soils that have a loamy subsoil; on uplands.

Subclass IVs. Soils very severely limited because of soil features.

Unit IVs–1. Deep, nearly level or gently sloping, well drained or moderately well drained silt loam, clay loam, or fine sandy loam soils that have a loamy or clayey subsoil; on uplands.

Unit IVs–2. Deep, nearly level, moderately well drained loam, silt loam, silty clay loam, silty clay, or clay soils that have a loamy or clayey subsoil; on flood plains.

Unit IVs–3. Deep, nearly level, somewhat excessively drained loamy fine sand soils that are underlain by sandy material; on flood plains.

Class V. Soils that are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife habitat.

Subclass Vw. Soils too wet for cultivation; drainage or protection not feasible.

Unit Vw–1. Deep, nearly level, somewhat excessively drained loamy fine sand, fine sandy loam, loam, or clay loam soils that are underlain by sandy material; on flood plains.

Unit Vw–2. Deep, nearly level, well drained or moderately well drained silty clay loam, loam, silty clay, and clay soils that have a loamy or clayey subsoil; on flood plains.

Class VI. Soils that have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture, range, or wildlife habitat.

Subclass VIe. Soils severely limited, chiefly by risk of erosion, unless protective cover is maintained.

Unit VIe–1. Deep, very gently sloping to sloping, well-drained silt loam and silty clay loam soils that have a loamy subsoil; on uplands.

Unit VIe–2. Deep, gently sloping to moderately steep, excessively drained or well-drained loamy fine sand soils that have a sandy subsoil or are underlain by sandy material; on uplands.

Unit VIe–3. A complex that consists of moderately deep, gently sloping to strongly sloping, well-drained fine sandy loam soils that have a loamy subsoil and of sandstone Rock outcrop; on uplands.

Unit VIe–4. Moderately deep, sloping or strongly sloping, well-drained silt loam soils that have a loamy subsoil; on uplands.

Unit VIe–5. Moderately deep, sloping or strongly sloping, well-drained clay loam or clay soils that have a clayey subsoil, on uplands.

Unit VIe–6. A complex that consists of moderately deep, nearly level to strongly sloping, well drained clay loam soils that have a clay subsoil and are on uplands and of deep, well drained or moderately well drained silty clay or clay soils that have a clayey subsoil and are on flood plains.

Unit VIe–7. Moderately deep and deep, sloping or strongly sloping, well-drained or somewhat excessively drained gravelly sandy loam or fine sandy loam soils that have a loamy or sandy subsoil; on uplands.

Unit VIe–8. A complex that consists of deep, very gently sloping to sloping, well-drained loam soils that have a loamy subsoil and of very gently sloping to strongly sloping anorthosite Rock outcrop; on uplands.

Subclass VIs. Soils severely limited because of droughtiness.

Unit VIs–1. Very shallow and shallow, very gently sloping or gently sloping, well-drained loam soils that are underlain by loamy material or bedrock; on uplands.

Class VII. Soils that have very severe limitations that make them unsuited to cultivation and restrict their use largely to range or wildlife habitat.

Subclass VIIs. Soils very severely limited, chiefly by soil features.

Unit VIIs–1. Moderately deep, gently sloping to moderately steep, well-drained cobbly loam soils that have a loamy subsoil; on uplands.

Unit VIIs–2. Deep, gently sloping to strongly sloping, well-drained cobbly loam soils that have a loamy or clayey subsoil; on uplands.

Unit VIIs–3. A complex that consists of deep, strongly sloping, well-drained cobbly loam soils that have a loamy or clayey subsoil and of strongly sloping to very steep granitic Rock outcrop; on uplands.

Unit VIIs–4. A complex that consists of moderately deep, very gently sloping to strongly sloping, well-drained clay loam soils that have a clayey subsoil and of clay and shale Rock outcrop; on uplands.

Unit VIIs–5. A complex that consists of moderately deep, gently sloping or moderately steep, well-drained loam soils that have a loamy subsoil and a clayey shale Rock outcrop; on uplands.

Unit VIIs–6. A complex that consists of very shallow and shallow, sloping to moderately steep, well-drained loam soils that are underlain by loamy material or bedrock, and limestone Rock outcrop; on uplands.

Class VIII. Soils and landforms that have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or esthetic purposes.

Subclass VIIIs. Landforms very severely limited because of lack of soil.

Unit VIIIs–1. Rock outcrop.

Estimated yields

Table 2 lists estimated yields of the principal crops grown in Kiowa County. The yields shown are based on estimates made by farmers, soil scientists, and others who have knowledge of yields in the county and on information taken from research data. The estimated yields are average yields per acre that can be expected by good commercial farmers at the level of management that tends to produce the highest economic returns.

Crops other than those shown in table 2 are grown in the county, but their estimated yields are not included because their acreage is small or reliable data

TABLE 2.—*Estimated average yields per acre of principal crops and pasture under a high level of management*

[Absence of yield figure indicates that crop is seldom grown or is not suited to the soil specified. Only arable soils are listed]

Soil	Wheat	Grain sorghum	Cotton	Alfalfa	Bermudagrass
	Bu	*Bu*	*Lb of lint*	*Tons*	*AUM*[1]
Altus fine sandy loam, 0 to 1 percent slopes	25	45	350	2.5	5.5
Altus fine sandy loam, 1 to 3 percent slopes	20	40	300	2.0	5.0
Carey silt loam, 1 to 3 percent slopes	20	40	300		5.5
Carey silt loam, 3 to 5 percent slopes	15	35	250		5.0
Carey silt loam, 2 to 5 percent slopes, eroded	10	20	150		
Carey-Hinkle complex, 1 to 5 percent slopes	10	20	150		4.5
Cobb fine sandy loam, 1 to 3 percent slopes	20	25	200		5.5
Cyril loam	30	50	500	3.5	8.0
Devol loamy fine sand, 0 to 3 percent slopes	20	30	250		5.5
Foard silt loam, 0 to 1 percent slopes	25	30	250		4.0
Grandfield loamy fine sand, 0 to 3 percent slopes	20	30	250		5.0
Grandfield fine sandy loam, 1 to 3 percent slopes	20	30	300	2.0	5.5
Hardeman fine sandy loam, 1 to 3 percent slopes	20	25	250		6.0
Hardeman fine sandy loam, 3 to 5 percent slopes	15	20	200		6.0
Hardeman fine sandy loam, 5 to 8 percent slopes	10	20			5.5
Hollister silty clay loam, 0 to 1 percent slopes	25	40	250		4.5
Hollister silty clay loam, 1 to 3 percent slopes	20	30	200		4.0
Hollister silty clay loam, 1 to 3 percent slopes, eroded	15	25	150		3.5
Indiahoma silty clay loam, 1 to 3 percent slopes	20	20	200		3.5
Indiahoma silty clay loam, 3 to 5 percent slopes	15	15	150		3.5
Lawton loam, 1 to 3 percent slopes	20	30	300	2.0	6.0
Lawton loam, 3 to 5 percent slopes	20	25	250		6.0
Lawton loam, 2 to 5 percent slopes, eroded	15	20			5.5
Lawton loam, 5 to 8 percent slopes	15	20			5.5
Lincoln loamy fine sand	15	15			5.0
Lugert loam	35	60	550	4.0	8.0
McLain silty clay loam	35	50	500	3.5	7.0
Meno loamy fine sand, 0 to 3 percent slopes	25	40	350	2.5	5.5
Miller clay	35	60	500	3.5	7.0
Miller soils, saline					6.5
Natrustalfs	10				2.0
Port silty clay loam	35	50	550	4.0	8.0
Reinach loam	35	50	550	4.0	8.0
Roscoe clay	20	30	225		
St. Paul silt loam, 0 to 1 percent slopes	25	35	350	2.5	5.0
St. Paul silt loam, 1 to 3 percent slopes	20	30	300	2.0	5.0
St. Paul-Hinkle complex, 0 to 1 percent slopes	15	25	200		4.0
Shellabarger fine sandy loam, 3 to 5 percent slopes	20	40	200		5.5
Tillman clay loam, 1 to 3 percent slopes	20	30	200		3.5
Tillman clay loam, 3 to 5 percent slopes	15	20			3.5
Tillman-Hinkle complex, 1 to 3 percent slopes	15	20			2.5
Tillman-Vernon complex, 2 to 5 percent slopes, eroded	10	10			3.0
Tobosa clay, 0 to 1 percent slopes	20	30	225		
Vernon clay loam, 2 to 5 percent slopes	10	15			
Yahola fine sandy loam	30	45	450	3.5	7.5

[1] AUM stands for animal-unit-month, a term used to express the carrying capacity of pasture. It is the number of animal units carried per acre multiplied by the number of months a pasture can be grazed during a single grazing season without injury to the sod. An acre of pasture that provides 2 months of grazing for two cows has a carrying capacity of 4 animal-unit-months.

on yields are not available. Absence of yield data indicates the crop is not suited to or is not commonly grown on the soil.

The estimated yields in table 2 can be expected if the following management practices are used:

1. Rainfall is effectively used and conserved.
2. Crop residue is managed to maintain soil structure and good tilth.
3. Tillage is minimum and timely.
4. Insect, disease, and weed control measures are consistently used.
5. Plant nutrients are applied according to soil tests and crop needs.
6. Adapted crop varieties are used at recommended seeding rates.

Management of the Soils for Pasture and Hay[3]

General guidelines for managing soils for pasture and hay are described in this section. Following this, 12 pasture and hay groups into which the soils have been placed are described. The pasture and hay group of a specific soil can be found by referring to the "Guide to Mapping Units" at the back of this survey. For detailed information about the management of soils refer to the section "Descriptions of the Soils."

Pasture plants are grown on most soils, except those soils that are shallow or very shallow. The principal grasses are improved bermudagrass and weeping love-

[3] M. D. GAMBLE, conservation agronomist, Soil Conservation Service, helped to prepare this section.

grass. Improved varieties under good management produce more forage than common bermudagrass. Sudan and sorghum hybrids are used for summer temporary pasture where perennial forage is in short supply. Fall-sown small grain, such as wheat, is used for fall, winter, and spring grazing.

Proper grazing helps to lengthen the life of most pasture. Applying a moderate amount of the proper plant nutrients results in more vigorous plants and more palatable forage. This helps to increase production and lengthen the lifespan of the pasture.

Pasture and hay groups

Soils in this county have been assigned to pasture and hay groups to help farmers select suitable forage plants for grazing livestock. These groups are described in the following pages. The soils of each group support similar pasture plants and require similar treatments and management.

PASTURE AND HAY GROUP 1A

In this group are deep, well drained or moderately well drained, loamy and clayey soils that have a loamy or clayey subsoil. These soils are on flood plains and are subject to flooding. Permeability is very slow.

PASTURE AND HAY GROUP 2A

In this group are deep, well-drained or moderately well drained, loamy soils that have a loamy or clayey subsoil or are underlain by loamy material. These soils are on flood plains or terraces and are subject to flooding. Permeability is slow to moderately rapid.

PASTURE AND HAY GROUP 2C

In this group are deep, moderately well drained, loamy or clayey soils that have a loamy or clayey subsoil. These soils are moderately or strongly affected by salinity. They are on flood plains and are subject to flooding. Permeability is very slow.

PASTURE AND HAY GROUP 3A

In this group are deep, somewhat excessively drained, loamy or sandy soils that are underlain by sandy material. These soils are on flood plains and are subject to flooding. Permeability is rapid.

PASTURE AND HAY GROUP 7A

In this group are deep, well drained or moderately well drained, loamy soils that have a clayey subsoil and clayey soils that are underlain by clayey material. These soils are on uplands. Permeability is very slow.

PASTURE AND HAY GROUP 8A

In this group are deep and moderately deep, well-drained or somewhat excessively drained, loamy or clayey soils that have a loamy, sandy, or clayey subsoil. These soils are on uplands. Permeability is moderately rapid to very slow.

PASTURE AND HAY GROUP 8D

In this group are deep, moderately well drained, loamy soils that have a loamy or clayey subsoil. These soils are high in content of exchangeable sodium. They are on uplands. Permeability is very slow.

PASTURE AND HAY GROUP 8F

In this group are severely eroded, deep, well-drained, loamy soils that have a loamy subsoil. These soils are on uplands. Permeability is moderate.

PASTURE AND HAY GROUP 9A

In this group are deep, well-drained, sandy soils that have a loamy or sandy subsoil. These soils are on uplands. Permeability is moderate or moderately rapid.

PASTURE AND HAY GROUP 9B

In this group are deep, well-drained or excessively drained, sandy soils that have a sandy subsoil or are underlain by sandy material. These soils are on uplands. Permeability is rapid.

PASTURE AND HAY GROUP 9C

In this group are deep, moderately well drained, sandy soils that have a loamy subsoil. These soils are on uplands. Permeability is moderate.

PASTURE AND HAY GROUP 14A

In this group are very shallow, well-drained, loamy soils that are underlain by loamy material or bedrock. These soils are on uplands. Permeability is moderate.

Range[4]

This section contains information about the use of the soils for range. Range is land on which the natural plant community is mainly grass, grasslike plants, forbs, and shrubs valuable for grazing and in sufficient quantity to justify grazing use. About 30 percent of Kiowa County is in native range on which domestic animals are raised. The range is usually grazed all year. During years of favorable moisture, forage sorghum and small grain are used to supplement the range. During the dormant season of the grasses, protein supplements and hay are fed.

Range sites and condition classes

Different kinds of soil vary in their capacity to produce grass and other plants for grazing. Soils that produce about the same kinds and amount of forage, if the range is in similar condition, make up a range site.

Range sites are kinds of rangeland that differ in their ability to produce vegetation. The soils of any one range site produce about the same kind and amount of climax vegetation. Throughout the prairie and the plains, the climax vegetation consists mainly of grasses and forbs. If cultivated crops are not grown, the most productive combination of forage plants on a range site is generally the climax, or potential, vegetation.

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and are the most palatable to livestock.

[4] ERNEST C. SNOOK and DAVID D. ANKLE, range conservationists, Soil Conservation Service, helped to prepare this section.

Increasers are plants in the climax vegetation that increase in relative amount as the more desirable decreaser plants are reduced by close grazing. They are commonly shorter than decreasers and are generally less palatable to livestock.

Invaders are plants that cannot compete with plants in the climax vegetation for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many invaders are annual weeds and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.

A range is in *excellent* condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand. It is in *good* condition if 51 to 75 percent; in *fair* condition if 26 to 50 percent; and in *poor* condition if 25 percent or less.

Range condition is judged according to standards that apply to the particular range site. It expresses the present kind and amount of vegetation in relation to the potential vegetation for that site.

Potential forage production depends on the range site. Current forage production depends on the range condition and the moisture available to plants during their growing season.

A primary objective of good range management is to keep range in excellent or good condition. If this is done water is conserved, yields are improved, and the soils are protected. The main concern of management is to recognize important changes in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Growth encouraged by heavy rainfall may lead to the conclusion that the range is in good condition, when actually the cover is weedy and the long-term trend is toward lower production. On the other hand, some range that has been closely grazed for short periods, under the supervision of a careful manager, may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of the range sites

In the following pages, the range sites of Kiowa County are described and the climax plants and principal invaders on the sites are named. The descriptions of the range sites also contain an estimate of the potential annual yield of air-dry herbage for each site if it is in excellent condition. The site for each soil in the county can be determined by referring to the "Guide to Mapping Units" at the back of this survey.

ALKALI BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, loamy or clayey soils that have a loamy or clayey subsoil. These soils are on flood plains that are subject to flooding. They are moderately or strongly affected by salts.

The approximate composition of the climax vegetation on range in excellent condition is 15 percent switchgrass, 10 percent western wheatgrass, 10 percent vine-mesquite, 15 percent alkali sacaton, 10 percent white tridens, 10 percent blue grama, 5 percent catclaw sensitivebrier, 5 percent inland saltgrass, 15 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, switchgrass, western wheatgrass, vine-mesquite, alkali sacaton, white tridens, and catclaw sensitivebrier decrease. Such plants as meadow dropseed, blue grama, inland saltgrass, buffalograss, and hairy goldaster increase. If overgrazing is prolonged, dropseeds, annual bromegrass, annual three-awn, and annual forbs make up a substantial part of the growth, and total production is greatly reduced. The spotty nature of the vegetation makes the site very difficult to manage.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 3,200 pounds per acre in years of favorable growing conditions and 1,800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, deferred grazing, range seeding, fencing, stock-water development, and weed management.

BOULDER RIDGE RANGE SITE

This site consists of deep, gently sloping to strongly sloping, loamy soils that have a loamy or clayey subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent big bluestem, 20 percent little bluestem, 10 percent side-oats grama, 5 percent indiangrass, 5 percent Canada wildrye, 5 percent blue grama, 20 percent other perennial grasses, and 10 percent other perennial forbs.

Under continued heavy grazing by livestock, little bluestem, big bluestem, indiangrass, Canada wildrye, prairie acacia, tickclover, Maximilian sunflower, and halfshrub sundrop decrease. Such plants as side-oats grama, blue grama, meadow dropseed, and heath aster increase. If overgrazing is prolonged, silver bluestem, buffalograss, perennial three-awn, sand dropseed, and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced. Some areas may be invaded by post oak, blackjack oak, and mesquite.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 4,000 pounds per acre in years of favorable growing conditions and 2,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, deferred grazing, fencing, and stock-water development.

DEEP SAND RANGE SITE

This site consists of deep, nearly level to moderately steep, sandy soils that have a loamy or sandy subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent little bluestem, 20 percent sand bluestem, 10 percent indiangrass, 5 percent switchgrass, 20 percent other perennial grasses, 10 percent other perennial forbs, and 10 percent shrubs.

Under continued heavy grazing by livestock, sand bluestem, little bluestem, indiangrass, switchgrass, Illinois bundleflower, and sand lovegrass decrease. Such plants as sand paspalum, tall dropseed, sand sagebrush, skunkbush, Texas bluegrass, bigtop dalea, queensdelight, and sand plum increase. If overgrazing is prolonged, sandbur, sand dropseed, red lovegrass, deervetch, wild buckwheat, camphorweed, locust, and coralberry make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 3,600 pounds per acre in years of favorable growing conditions and 1,800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, deferred grazing, range seeding, fencing, stock-water development, and brush and weed management.

DUNE RANGE SITE

This site consists of deep, gently sloping to moderately steep, sandy soils that are underlain by sandy material. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent sand bluestem, 20 percent little bluestem, 10 percent big sandreed, 5 percent blue grama, 5 percent sand dropseed, 5 percent sand paspalum, 5 percent side-oats grama, 5 percent sand sagebrush, 5 percent skunkbush, 10 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, sand bluestem, little bluestem, and big sandreed decrease. Such plants as blue grama, sand dropseed, sand paspalum, side-oats grama, sand sagebrush, and skunkbush increase. If overgrazing is prolonged, red lovegrass, purple sandgrass, three-awns, ragweed, and annual grasses and forbs make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,600 pounds per acre in years of favorable growing conditions and 800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, deferred grazing, and fencing.

EDGEROCK RANGE SITE

This site consists of very shallow and shallow, strongly sloping or moderately steep, loamy soils that are underlain by loamy material or bedrock. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 20 percent little bluestem, 20 percent side-oats grama, 15 percent blue grama, 10 percent buffalograss, 10 percent hairy grama, 5 percent big bluestem, 15 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, little bluestem, side-oats grama, big bluestem, and prairie-clover decrease. Such plants as blue grama, buffalograss, hairy grama, dropseeds, and longleaf wild-buckwheat increase. If overgrazing is prolonged, silver bluestem, windmillgrass, tumblegrass, hairy tridens, western ragweed, and annual grasses and forbs make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable growing conditions and 1,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, and deferred grazing.

ERODED PRAIRIE RANGE SITE

This site consists of severely eroded, deep, very gently sloping to sloping, loamy soils that have a loamy subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 35 percent little bluestem, 20 percent side-oats grama, 15 percent sand bluestem, 10 percent blue grama, 5 percent buffalograss, 10 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, little bluestem, side-oats grama, and sand bluestem decrease. Such plants as tall dropseed, blue grama, buffalograss, dotted gayfeather, sumac, and sand plum increase. If overgrazing is prolonged, silver bluestem, annual bromes, three-awns, showy partridgepea, common broomweed, ragweed, and yarrow make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable growing conditions and 800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, range seeding, a planned grazing system, deferred grazing, stock-water development, fencing, and brush and weed management.

ERODED RED CLAY RANGE SITE

Only Rock outcrop is in this site. It consists of raw clay interbedded with shale and soil material less than 4 inches thick. It is very gently sloping to strongly sloping and is on nearly barren flats, escarpments, and side slopes (fig. 10).

The approximate composition of the climax vegetation on range in excellent condition is 35 percent side-oats grama, 15 percent alkali sacaton, 5 percent sand bluestem, 5 percent little bluestem, 5 percent silver bluestem, 5 percent dropseed, 20 percent other perennial grasses, and 10 percent other perennial forbs.

Under continued heavy grazing by livestock, side-oats grama, sand bluestem, little bluestem, heath aster, and scurf-pea decrease. Such plants as alkali sacaton, silver bluestem, dropseed, buffalograss, and a number of legumes, some of which are poisonous, increase. If overgrazing is prolonged, tumblegrass, windmillgrass, pricklypear cactus, mesquite, and annual grasses and forbs make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 600 pounds per acre in years of favorable growing conditions and 200 pounds per acre in unfavorable years.

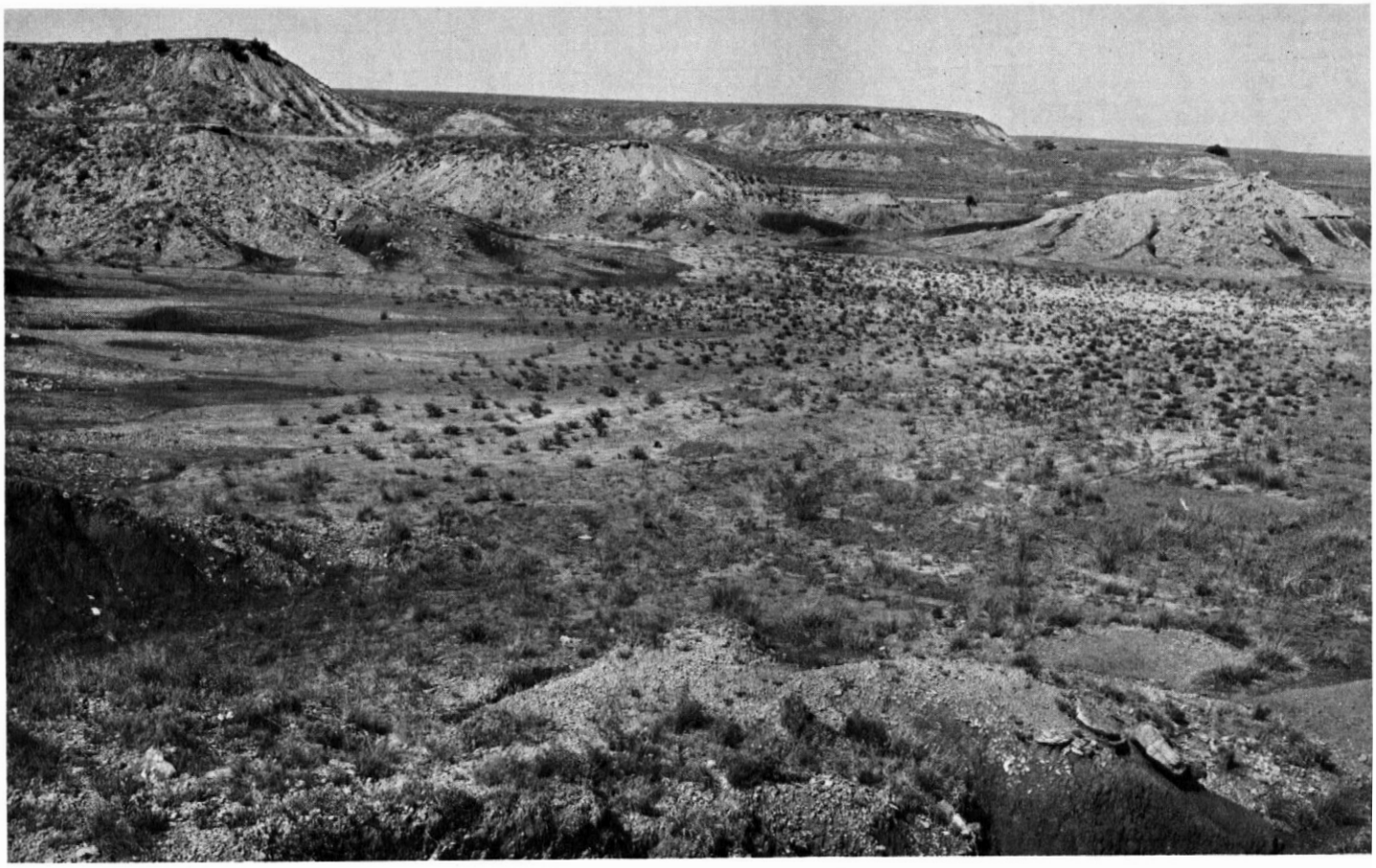


Figure 10.—Eroded Red Clay range site in background and Red Clay Prairie range site in foreground, in area of Vernon-Rock outcrop complex, 2 to 12 percent slopes.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, and fencing.

HARDLAND RANGE SITE

This site consists of deep, nearly level to gently sloping, loamy or clayey soils that have a loamy or clayey subsoil and clayey soils that are underlain by clayey material. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 30 percent side-oats grama, 20 percent blue grama, 10 percent western wheatgrass, 10 percent buffalograma, 5 percent sand bluestem, 5 percent vine-mesquite, 15 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, side-oats grama, sand bluestem, western wheatgrass, vine-mesquite, and heath aster decrease. Such plants as blue grama, buffalograss, purple three-awn, meadow dropseed, and dotted gayfeather increase. If overgrazing is prolonged, red three-awn, sand dropseed, silver bluestem, curlycup gumweed, western ragweed, and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,900 pounds per acre in years of favorable growing conditions and 1,500 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, cross-fencing, range seeding, fencing, and weed management.

HEAVY BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, loamy or clayey soils that have a loamy or clayey subsoil. These soils are on flood plains or terraces and are subject to flooding (fig. 11).

The approximate composition of the climax vegetation on range in excellent condition is 20 percent switchgrass, 15 percent little bluestem, 10 percent western wheatgrass, 10 percent Texas wintergrass, 10 percent alkali sacaton, 5 percent vine-mesquite, 5 percent blue grama, 10 percent sedges, 10 percent

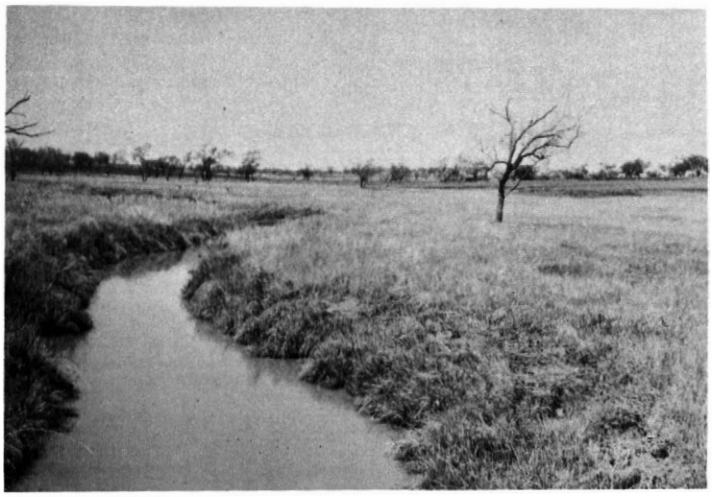


Figure 11.—A Heavy Bottomland range site showing invasion of mesquite in the background because of overgrazing. The soil is Miller clay.

other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, switchgrass, sand bluestem, little bluestem, western wheatgrass, vine-mesquite, and Maximilian sunflower decrease. Such plants as Texas wintergrass, blue grama, alkali sacaton, meadow dropseed, buffalograss, and sedges increase. If overgrazing is prolonged, windmill grass, three-awns, curlycup gumweed, mesquite, and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 4,500 pounds per acre in years of favorable growing conditions and 2,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, cross-fencing, brush and weed management, fencing, and range seeding.

HILLY STONY RANGE SITE

This site consists of deep, strongly sloping loamy soils that have a loamy or clayey subsoil and of Rock outcrop, which is strongly sloping to very steep, parallel outcrops of tilted limestone. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent little bluestem, 15 percent big bluestem, 15 percent side-oats grama, 10 percent hairy grama, 10 percent blue grama, 5 percent indiangrass, 10 percent other perennial grasses, and 10 percent other perennial forbs.

Under continued heavy grazing by livestock, little bluestem, big bluestem, indiangrass, side-oats grama, Scribners panicum, prairie-clover, prairie coneflower, and sundrops decrease. Such plants as hairy grama, blue grama, buffalograss, perennial three-awn, Texas grama, skullcap, and longleaf wild-buckwheat increase. If overgrazing is prolonged, hairy tridens, sand dropseed, silver bluestem, and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced. Some areas have been invaded by such woody plants as post oak, blackjack oak, live oak, and mountain walnut.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable growing conditions and 1,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, and deferred grazing.

LIMESTONE RIDGE RANGE SITE

This site consists of moderately deep, gently sloping to moderately steep, loamy soils that have a loamy subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 35 percent side-oats grama, 10 percent little bluestem, 10 percent big bluestem, 10 percent hairy grama, 5 percent tall grama, 5 percent blue grama, 5 percent tridens, 5 percent skunkbush, 10 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, big bluestem, little bluestem, side-oats grama, and purple three-awn decrease. Such plants as hairy grama, tall grama, blue grama, tridens, tall dropseed, skunkbush, and pricklypear cactus increase. If overgrazing is prolonged, red three-awn and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 3,000 pounds per acre in years of favorable growing conditions and 1,500 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, and fencing.

LOAMY BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, loamy soils that have a loamy subsoil or that are underlain by loamy material. These soils are on flood plains and terraces and are subject to flooding.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent big bluestem, 15 percent indiangrass, 15 percent switchgrass, 10 percent little bluestem, 5 percent eastern gamagrass, 5 percent tall dropseed, 10 percent other perennial grasses, 10 percent other perennial forbs, and 5 percent trees.

Under continued heavy grazing by livestock, big bluestem, indiangrass, switchgrass, eastern gamagrass, little bluestem, and compassplant decrease. Such plants as beaked panicum, tall dropseed, heath aster, sedges, and such woody plants as elms, pecan, black walnut, and greenbrier increase. If overgrazing is prolonged, annual bromes, silver bluestem, three-awns, ragweeds, ironweed, and white snakeroot make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 7,000 pounds per acre in years of favorable growing conditions and 4,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, cross-fencing, brush management, fencing, weed management, and range seeding.

LOAMY PRAIRIE RANGE SITE

This site consists of deep or moderately deep, nearly level to strongly sloping, loamy soils that have a loamy subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent little bluestem, 20 percent big bluestem and sand bluestem, 10 percent switchgrass, 10 percent indiangrass, 5 percent side-oats grama, 5 percent blue grama, 15 percent other perennial grasses, 8 percent other perennial forbs, and 2 percent shrubs.

Under continued heavy grazing by livestock, little bluestem, big bluestem, sand bluestem, switchgrass, indiangrass, Canada or Virginia wildrye, and perennial lespedeza decrease. Such plants as tall dropseed, side-oats grama, blue grama, dotted gayfeather, sumac, and sand plum increase. If overgrazing is prolonged, silver bluestem, annual bromes, three-awns, showy partridgepea, common broomweed, ragweed, and yarrow make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 4,200 pounds per acre in years of favorable growing conditions and 1,800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, brush management, fencing, weed management, and range seeding.

RED CLAY PRAIRIE RANGE SITE

This site consists of moderately deep, very gently sloping to strongly sloping, loamy or clayey soils that have a clayey subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 30 percent side-oats grama, 25 percent little bluestem, 10 percent blue grama, 5 percent big or sand bluestem, 5 percent vine-mesquite, 5 percent hairy grama, 5 percent buffalograss, 10 percent other perennial grasses, and 5 percent other perennial forbs.

Under continued heavy grazing by livestock, little bluestem, big bluestem, sand bluestem, vine-mesquite, prairie-clover, and sundrops decrease. Such plants as side-oats grama, blue grama, hairy grama, buffalograss, silver bluestem, and purple three-awn increase. If overgrazing is prolonged, red three-awn, sand dropseed, annual grasses and forbs, pricklypear cactus, and mesquite make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,200 pounds per acre in years of favorable growing conditions and 1,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, fencing, brush and weed management, and range seeding.

SANDY BOTTOMLAND RANGE SITE

This site consists of deep, nearly level, sandy or loamy soils that are underlain by sandy material. These soils are on flood plains and are subject to flooding.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent switchgrass, 15 percent sand bluestem, 15 percent indiangrass, 5 percent little bluestem, 5 percent beaked panicum, 5 percent purpletop, 15 percent other perennial grasses, 10 percent other perennial forbs, and 5 percent trees.

Under continued heavy grazing by livestock, sand bluestem, little bluestem, indiangrass, switchgrass, and Maximilian sunflower decrease. Such plants as side-oats grama, Canada wildrye, beaked panicum, purpletop, goldenrods, willow, and cottonwood increase. If overgrazing is prolonged, dropseeds, silver bluestem, windmillgrass, saltcedar, and annual grasses and forbs make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 3,000 pounds per acre in years of favorable growing conditions and 1,800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a planned grazing system, deferred grazing, range seeding, fencing, stock-water development, and brush and weed management.

SANDY PRAIRIE RANGE SITE

This site consists of moderately deep or deep, nearly level to strongly sloping, loamy soils that have a loamy or sandy subsoil. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 30 percent little bluestem, 15 percent sand bluestem, 10 percent indiangrass, 5 percent Canada Wildrye, 5 percent Scribners panicum, 5 percent side-oats grama, 5 percent blue grama, 10 percent other perennial grasses, 10 percent other perennial forbs, and 5 percent trees.

Under continued heavy grazing by livestock, little bluestem, sand bluestem, Canada wildrye, indiangrass, prairie-clover, and halfshrub sundrop decrease. Such plants as Scribners panicum, sand paspalum, side-oats grama, yucca, sumac, skunkbush, and coralberry increase. If overgrazing is prolonged, sand dropseed, stinkgrass, windmillgrass, sandbur, croton, nightshade, oak, and western soapberry make up a substantial part of the growth, and total production is greatly reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 4,000 pounds per acre in years of favorable growing conditions and 2,000 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, brush management, fencing, weed management, and range seeding.

SHALLOW PRAIRIE RANGE SITE

This site consists of very shallow and shallow, very gently sloping or gently sloping, loamy soils that are underlain by loamy material or bedrock. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 30 percent little bluestem, 15 percent big bluestem and sand bluestem, 10 percent indiangrass, 10 percent switchgrass, 5 percent tall dropseed, 5 percent side-oats grama, 5 percent Scribners panicum, 10 percent other perennial grasses, 5 percent other perennial forbs, and 5 percent shrubs.

Under continued heavy grazing by livestock, little bluestem, big bluestem, sand bluestem, indiangrass, switchgrass, and perennial sunflower decrease. Such plants as side-oats grama, hairy grama, Scribners panicum, tall dropseed, dotted gayfeather, sumac, coralberry, and blackberry increase. If overgrazing is prolonged, three-awns, ragweeds, common yarrow, bitter sneezeweed, and persimmon make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 2,200 pounds per acre in years of favorable growing conditions and 1,100 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, a deferred grazing system, stock-water development, range seeding, and brush and weed management.

SLICKSPOT RANGE SITE

This site consists of deep, nearly level or very gently sloping, loamy soils that have a loamy subsoil that is 15 to 25 percent exchangeable sodium. These soils are on uplands.

The approximate composition of the climax vegetation on range in excellent condition is 25 percent blue grama, 15 percent little bluestem, 10 percent alkali sacaton, 5 percent switchgrass, 5 percent tall dropseed, 5 percent white tridens, 25 percent blue grama, 5 percent side-oats grama, 5 percent whorled dropseed, 5 percent silver bluestem, 10 percent other perennial grasses, and 10 percent other perennial forbs.

Under continued heavy grazing by livestock, alkali sacaton, switchgrass, little bluestem, tall dropseed, white tridens, and yellow neptunia decrease. Such plants as blue grama, side-oats grama, whorled dropseed, fall witchgrass, silver bluestem, hairy goldaster, and wild alfalfa increase. If overgrazing is prolonged, annual grasses and forbs make up a substantial part of the growth, and total production is reduced.

If this site is in excellent condition, the total annual yield of air-dry herbage is about 1,800 pounds per acre in years of favorable growing conditions and 800 pounds per acre in unfavorable years.

Range management practices that are suitable for this site are proper grazing use, deferred grazing, a planned grazing system, stock-water development, and range seeding.

Use of the Soils for Trees and Shrubs[5]

This section contains information about the suitability of the soils in Kiowa County for trees and shrubs. Trees grow in Kiowa County only in narrow bands along the rivers and their tributaries and in areas on the sides of mountains. The principal species are cottonwood, black willow, tamarisk, American elm, bur oak, pecan, hackberry, soapberry, green ash, and associated species. Other tree species in the county are plum, red mulberry, western walnut, honeylocust, Kentucky coffee tree, redbud, osageorange, shumard oak, live oak, post oak, blackjack oak, durand oak, black locust, chittamwood, button bush, roughleaf dogwood, sumac, eastern redcedar, and redberry juniper. Except for their watershed, wildlife, and esthetic value, natural stands of woodland in the county have only limited economic value.

Farmstead windbreaks that are properly designed and located help to reduce drifting of snow and keep snow out of farmyards. They also shelter the home and farmyard. A good farmstead windbreak increases the value of a farm.

Belts of trees are useful in screening unsightly areas. Properly planned tree and shrub screens reduce noise. Tree plantings add esthetic value to most areas and help to control erosion.

On most soils, preparation for tree planting can be the same as for ordinary field crops. Even though many of the species used are native to this county, they are not found growing naturally on soils where trees are needed. They need special care. A soil that has a less than severe hazard of erosion can be prepared far enough in advance so that it will have time to settle. Alfalfa and grass sod should be summer fallowed at least 1 year before planting, and cropland can be plowed in fall. Adequate cover or crop residue should be maintained on soils that have a severe hazard of erosion. Cover crops protect the soil both before and after planting and also protect the young seedlings.

Careful planning is needed for every tree planting if it is to be most effective. When choosing stock for planting, it is preferable to select species that grow best on the type of soil found at the planting location.

Soils that have similar characteristics that affect tree growth have been placed in tree and shrub groups. The recommended trees for each tree and shrub group are included in the descriptions of the group. Healthy seedlings should be purchased from reputable nurseries or other agencies. The seedlings should be planted late in winter or early in spring. They should be protected from drying out while being planted, and the ground should be packed firm around the roots.

Young trees need considerable care if they are to survive and do well on most of the soils. If rainfall is limited and irregular, weeds need to be controlled so that they do not compete for moisture. This can be

[5] NORMAN E. SMOLA, forester, Soil Conservation Service, helped to prepare this section.

done by cultivating or by using chemical weed killers. Trees need to be protected from damage by livestock and fire. Additional information about appropriate design for the desired purpose and about the planting and care of tree plantings is available from the Soil Conservation Service, the State forester, and the Extension Service.

The kind of soil and the soil-air-moisture relationship greatly influence the growth of trees. Trees normally grow best on deep sandy loam soils. Growth is only fair to poor on shallow or severely eroded soils, because such soils absorb and release moisture too slowly. Deep soils are better suited than shallow soils because more moisture can be stored for use during droughty periods. Hardwoods require deeper soils than conifers, although conifers make their best growth on the soils that are suited to farming.

Such conifers as pine and eastern redcedar at first grow slower than hardwoods, but their growth is likely to equal that of most hardwoods as they mature. Conifers surpass hardwoods in length of life and in overall effectiveness as windbreaks.

Available water capacity, soil fertility, tree spacing, adaptability of the tree to the soil, and the care given to the tree all affect the rate of tree growth.

Tree and shrub groups

The soils in Kiowa County have been assigned to nine tree and shrub groups. The soils in each group have similar characteristics that affect tree growth. The group for each soil can be found by referring to the "Guide to Mapping Units" at the back of this survey.

Following are brief descriptions of the tree and shrub groups in Kiowa County and a list of trees and shrubs suitable for planting on the soils in each group. Also in the descriptions of the tree and shrub groups is the estimated height at an age of 20 years for certain species suggested for planting.

TREE AND SHRUB GROUP 1

In this group are nearly level soils on flood plains and terraces. These soils are medium textured or moderately fine textured throughout, deep, and well drained. Moisture competition from weeds and grasses is the principal hazard to the establishment of trees. Estimated tree height at 20 years of age is 60 to 70 feet for eastern cottonwood and 25 to 35 feet for eastern redcedar.

Conifers suitable for planting are Austrian pine, shortleaf pine, loblolly pine, Scotch pine, ponderosa pine, oriental arborvitae, and eastern redcedar. Suitable broadleaf trees are eastern cottonwood, sycamore, hackberry, bur oak, honeylocust, green ash, black walnut, northern catalpa, osageorange, and black locust. Shrubs suitable for planting are American plum and autumn-olive.

TREE AND SHRUB GROUP 2

In this group are nearly level soils on flood plains and terraces. The flood plains range from about 100 feet to one-half mile or more in width. These soils are moderately fine textured, fine textured, or medium textured; deep; and well drained or moderately well drained. Drought and moisture competition from weeds and grasses are the principal hazards to the establishment of trees. The clayey subsoil also makes tree establishment difficult. Unless the trees are given additional water during normal years, initial survival will be low. Field windbreaks are generally not needed. Estimated tree height at 20 years of age is 45 to 55 feet for eastern cottonwood and 15 to 25 feet for eastern redcedar.

Conifers suitable for planting are eastern redcedar and one-seed juniper. Suitable medium to tall broadleaf trees are eastern cottonwood, bur oak, osageorange, green ash, pecan, and honeylocust. American plum is a suitable shrub.

TREE AND SHRUB GROUP 3

In this group are nearly level soils on flood plains. These soils are medium textured or moderately coarse textured throughout, deep, and well drained. Moisture competition from weeds and grasses is the principal hazard to the establishment of trees. Estimated tree height at 20 years of age is 50 to 60 feet for eastern cottonwood and 20 to 30 feet for eastern redcedar.

Conifers suitable for planting are Austrian pine, shortleaf pine, loblolly pine, Scotch pine, oriental arborvitae, and eastern redcedar. Suitable broadleaf trees are eastern cottonwood, sycamore, honeylocust, northern catalpa, osageorange, and black locust. Shrubs suitable for planting are American plum and autumn-olive.

TREE AND SHRUB GROUP 4

In this group are nearly level soils on flood plains. These soils have a coarse textured, moderately coarse textured, medium textured, or moderately fine textured surface layer and sandy underlying material. They have a seasonal water table at a depth of 8 or 9 feet. They are somewhat excessively drained. Soil blowing is a hazard on these soils. Flooding can be a hazard to the establishment of trees. Estimated tree height at 20 years of age is 45 to 55 feet for eastern cottonwood and 17 to 27 feet for eastern redcedar.

Conifers suitable for planting are ponderosa pine, eastern redcedar, oriental arborvitae, and Scotch pine. Suitable broadleaf trees are eastern cottonwood, sycamore, osageorange, and black locust. American plum is a suitable shrub.

TREE AND SHRUB GROUP 5

In this group are nearly level to strongly sloping soils on uplands. These soils have a medium textured, moderately coarse textured, or coarse textured surface layer and a moderately fine textured, medium textured, moderately coarse textured, or coarse textured subsoil. They are deep or moderately deep and are well drained or moderately well drained. Soil blowing and erosion are hazards. Soils on slopes of more than 8 percent cannot be safely cultivated. Competition from weeds and grasses is the principal hazard to the establishment of trees. Estimated tree height at 20 years of age is 20 to 30 feet for eastern redcedar and 20 to 30 feet for Austrian pine.

Conifers suitable for planting are Austrian pine, shortleaf pine, ponderosa pine, oriental arborvitae, and eastern redcedar. Suitable broadleaf trees are hack-

berry, honeylocust, eastern cottonwood, bur oak, osage-orange, and black-locust. Shrubs suitable for planting are American plum and autumn-olive.

TREE AND SHRUB GROUP 6

In this group are nearly level to strongly sloping soils on uplands. These soils have a medium textured, moderately fine textured, or fine textured surface layer and a fine textured, moderately fine textured, or medium textured subsoil or fine textured underlying material. They are deep or moderately deep and are well drained or moderately well drained. Drought and moisture competition from weeds and grasses are the principal hazards to the establishment of trees. The clayey subsoil also makes tree establishment difficult. Unless the trees are given additional water during normal years, initial survival will be low. Field windbreaks are not recommended for these soils. Once the trees are established, growth is slow and trees lose their vigor early unless irrigation is provided during droughty periods. Estimated height at 20 years of age is 10 to 20 feet for eastern redcedar.

Conifers suitable for planting are eastern redcedar and one-seed juniper. Suitable medium to tall broadleaf trees are honeylocust and osageorange. There are no shrubs suitable for planting.

TREE AND SHRUB GROUP 7

In this group are nearly level to strongly sloping soils on uplands. These soils have a coarse textured or moderately coarse textured surface layer and a coarse textured, moderately coarse textured, or medium textured subsoil. They are deep or moderately deep and are well drained or somewhat excessively drained. Competition from weeds and grasses and soil blowing are the principal hazards to the establishment of trees. Estimated tree height at 20 years of age is 40 to 50 feet for eastern cottonwood, 15 to 25 feet for eastern redcedar, and 15 to 25 feet for Austrian pine.

Conifers suitable for planting are Austrian pine, Scotch pine, ponderosa pine, oriental arborvitae, and eastern redcedar. Suitable broadleaf trees are eastern cottonwood, honeylocust, black locust, and osageorange. Shrubs suitable for planting are American plum and autumn-olive.

TREE AND SHRUB GROUP 8

In this group are gently sloping to moderately steep soils on uplands. These soils are sandy throughout, deep, and excessively drained or well drained. They cannot be safely cultivated. Lack of adequate moisture and soil blowing are severe hazards to the establishment of trees during normal years. Estimated tree height at 20 years of age is 13 to 23 feet for eastern redcedar and 13 to 23 feet for ponderosa pine.

Conifers suitable for planting are eastern redcedar, oriental arborvitae, ponderosa pine, and Scotch pine. A suitable broadleaf tree is osageorange. American plum is a suitable shrub.

TREE AND SHRUB GROUP 9

In this group are nearly level to strongly sloping soils on uplands. These soils are fine textured to moderately coarse textured throughout, very shallow to deep, and well drained or moderately well drained. Some are affected by exchangeable sodium, and some are severely eroded. Also in this group are deep, nearly level, well drained or moderately well drained soils on flood plains. They are subject to flooding, and some are affected by salinity. The surface layer is medium textured to fine textured, and the subsoil is moderately fine textured or fine textured. Also in this group are outcrops of sandstone, shale, anorthosite, granite, or limestone.

Droughtiness, lack of an adequate rooting depth, and salinity make these soils generally unsuited to tree and shrub plantings.

Wildlife[6]

This section has information about suitability of the soils of Kiowa County for wildlife habitat. Soils directly influence the kind and amounts of vegetation and the amounts of water available and thereby influence the kinds of wildlife that can live in an area. Soil properties that affect the growth of wildlife habitat are thickness of soil useful to crops, texture of the surface layer, available water capacity, wetness, hazard of flooding, slope, and permeability of the soil to air and water.

In table 3 the soils of Kiowa County are rated for producing six elements of wildlife habitat and for three groups, or kinds, of wildlife. The ratings indicate relative suitability for various elements.

A rating of *good* means that the elements of wildlife habitat and the kinds of habitat generally are easily created, improved, and maintained. Few or no limitations affect management, and satisfactory results are expected.

A rating of *fair* means that the elements of wildlife habitat and the kinds of habitat can be created, improved, or maintained in most places. A moderate intensity of management and fairly frequent attention may be required for satisfactory results.

A rating of *poor* means that limitations for the designated use are severe. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort.

A rating of *very poor* means that limitations to use of the soil for wildlife habitat are very severe, and unsatisfactory results are likely. It is impractical to create, improve, or maintain habitat on soils in this category.

Each soil is rated in table 3 according to its suitability for producing various kinds of plants and other elements that make up wildlife habitat. The ratings take into account mainly the characteristics of the soils and closely related natural factors of the environment. They do not take into account climate, present use of the soils, or present distribution of wildlife and people. For this reason, selection of a site for development as habitat for wildlife requires inspection at the site.

The elements of wildlife habitat rated in table 3 are briefly described in the following paragraphs.

Grain and seed crops.—These crops are annual grain-producing plants, such as wheat, sorghum, millet, and soybeans.

[6] JEROME F. SYKORA, biologist, Soil Conservation Service, helped to prepare this section.

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife*

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land	Wetland	Range-land
Albion: AsE. For Shellabarger part, see Shellabarger series.	Fair	Fair	Fair	Poor	Very poor.	Very poor.	Fair	Very poor.	Poor.
Altus: AtA, AtB	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
Brico: BrE	Fair	Fair	Fair	Poor	Very poor.	Very poor.	Fair	Very poor.	Fair.
Carey: CaB, CaC, CaC2, CbD. For Hinkle part of CbD, see Hinkle series.	Good	Good	Fair	Fair	Very poor.	Very poor.	Good	Very poor.	Fair.
CeD3	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Clairemont: Cm. For Mangum part, see Mangum series.	Poor	Fair	Fair	Good	Poor	Very poor.	Fair	Very poor.	Fair.
Cobb: CoB	Fair	Good	Good	Poor	Poor	Very poor.	Fair	Very poor.	Fair.
Cyril: Cy	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
Devol: DeB	Fair	Fair	Good	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
Dill: DrE. Rock outcrop part not rated.	Fair	Good	Good	Fair	Very poor.	Very poor.	Good	Very poor.	Fair.
Foard: FdA	Good	Good	Very poor.	Very poor.	Poor	Poor	Fair	Very poor.	Very poor.
Gotebo: GbE, GcF. Rock outcrop part of GcF not rated.	Poor	Fair	Good	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Grandfield: GnB	Fair	Fair	Good	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
GrB	Good	Good	Good	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Hardeman: HaB, HaC	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
HaD	Fair	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Very poor.
Hinkle. Mapped only with Carey, St. Paul, and Tillman soils.	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Poor	Very poor.	Very poor.
Hollister: HoA, HoB, HoB2.	Good	Good	Fair	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Indiahoma: InB, InC	Good	Good	Fair	Poor	Poor	Very poor.	Fair	Very poor.	Fair.
Lawton: LaB	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.
LaC, LaC2, LaD, LbE. Rock outcrop part of LbE not rated.	Fair	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife—Continued*

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land	Wetland	Range-land
Lincoln:									
Ln	Fair	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Lo	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Lugert: Lu	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
Mangum. Mapped only with Claire-mont and Ver-non soils.	Poor	Fair	Poor	Fair	Poor	Very poor	Poor	Very poor	Poor.
McLain: Mc	Good	Good	Fair	Fair	Good	Good	Good	Good	Fair.
Meno: MeB	Fair	Fair	Good	Good	Poor	Poor	Fair	Poor	Good.
Miller:									
Mr	Fair	Fair	Poor	Poor	Poor	Poor	Fair	Poor	Poor.
Ms	Fair	Fair	Fair	Poor	Poor	Poor	Fair	Poor	Poor.
Natrustalfs: Na	Poor	Poor	Very poor	Very poor	Very poor	Poor	Poor	Very poor	Very poor.
Port: Po	Good	Good	Fair	Good	Poor	Very poor	Good	Very poor	Fair.
Pratt. Mapped only with Tivoli soils.	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Reinach: Re	Good	Good	Good	Good	Poor	Very poor	Good	Very poor	Good.
Rock outcrop: Rk, RoF. Too variable to rate; for Brico part of RoF, see Brico series.									
Roscoe: Rs	Fair	Fair	Poor	Fair	Good	Poor	Fair	Fair	Poor.
St. Paul: SaA, SaB, SbA. For Hinkle part of SbA, see Hinkle series.	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
Shellabarger: ShC	Fair	Good	Good	Poor	Poor	Very poor	Good	Very poor	Fair.
Somervell: SoF	Very poor	Very poor	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Talpa: TaC, TbF. Rock outcrop part of TbF not rated.	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor	Very poor.
Tillman: TcB, TcC, TdB, ToC2. For Hinkle part of TdB, see Hinkle series; for Vernon part of ToC2, see Vernon series.	Good	Good	Fair	Fair	Very poor	Very poor	Good	Very poor	Fair.
Tivoli: TpF. For Pratt part, see Pratt series.	Poor	Poor	Fair	Poor	Very poor	Very poor	Poor	Very poor	Poor.

TABLE 3.—*Suitability of the soils for elements of wildlife habitat and for kinds of wildlife—Continued*

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Open-land	Wetland	Range-land
Tobosa: TsA	Fair	Fair	Poor	Fair	Good	Poor	Fair	Fair	Poor.
Vernon:									
VeC	Fair	Good	Fair	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
VmE, VrE, VsE	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
For Mangum part of VmE, see Mangum series; Rock outcrop part of VrE not rated.									
Yahola: Ya	Good	Good	Good	Good	Poor	Very poor.	Good	Very poor.	Good.

Grasses and legumes.—These are domestic grasses and legumes that are established by planting and provide food and cover for wildlife. Grasses include bermudagrass and weeping lovegrass. Legumes include alfalfa, clovers, peas, and lespedezas.

Wild herbaceous plants.—This group consists of native grasses, forbs, legumes, and weeds that provide food and cover for wildlife. Grasses include bluestems, switchgrass, other panicums, foxtail, wildryes, wild buckwheats, and annual bromes. Legumes include lespedezas, wild beans, Illinois bundleflower, tickclovers, and scurf-peas. Forbs and weeds include croton, sunflower, ragweed, pigweed, pokeweed, nightshades, Queensdelight, blacksamson, and pricklepoppy.

Shrubs.—This group consists of shrubs, coniferous plants, and woody vines that provide wildlife food in the form of fruits, nuts, buds, catkins, or browse. Such plants commonly grow in their natural environment, but they may be planted. Typical species in this category are American plum, chittamwood, skunkbush, sumac, greenbrier, roughleaf dogwood, and redcedar.

Wetland plants.—In this group are herbaceous plants that grow wild on moist and wet sites and furnish food and cover mostly for wetland wildlife. Typical examples are smartweed, wild millet, rushes, barnyardgrass, and sedges.

Shallow water areas.—These developments are impoundments or excavations for controlling water, generally no more than 5 feet deep, to create habitat that is suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatics.

Table 3 also rates the soils according to their suitability as habitat for the three kinds of wildlife in the county—open-land, wetland, and rangeland wildlife. These ratings are related to ratings made for the elements of habitat. For example, soils rated very poor for shallow water areas are rated very poor for wetland wildlife.

The kinds of wildlife for which the soils are rated in table 3 are briefly described in the following paragraphs.

Open-land wildlife consists of birds and mammals that normally live in meadows, pastures, and open areas where grasses, herbs, and shrubby plants grow. Quail, doves, meadowlarks, field sparrows, rabbit, and fox are examples of open-land wildlife.

Wetland wildlife consists of birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, rails, shore birds, herons, mink, beaver, and muskrats are examples of wetland wildlife.

Rangeland wildlife consists of birds and mammals of natural range. Examples are antelope, white-tailed deer, prairie chicken, quail, meadowlark, dove, turkey, and squirrel. These species are present along timbered drainageways.

Use of the Soils for Recreational Development

Knowledge of soils is necessary in planning, developing, and maintaining areas used for recreation. In table 4 the soils of Kiowa County are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails.

In table 4 the soils are rated as having slight, moderate, or severe limitations for the specified uses. For all of these ratings, it is assumed that a good cover of vegetation can be established and maintained. A limitation of *slight* means that soil properties are generally favorable and limitations are so minor that they easily can be overcome. A *moderate* limitation can be overcome or modified by planning, design, or special maintenance. A *severe* limitation means that costly soil reclamation, special design, intense maintenance, or a combination of these is required.

Camp areas are used intensively for tents and small camp trailers and the accompanying activities of outdoor living. Little preparation of the site is required other than shaping and leveling for tent and parking areas. Camp areas are subject to heavy foot traffic and

TABLE 4.—*Degree and kind of limitations for recreational uses*

["Percs slowly," "floods," and other terms that describe restrictive soil features in this table are explained in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Albion: AsE For Shellabarger part, see Shellabarger series.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Altus:				
AtA	Slight	Slight	Slight	Slight.
AtB	Slight	Slight	Moderate: slope	Slight.
Brico: BrE	Moderate: percs slowly; small stones; slope.	Moderate: small stones; slope.	Severe: small stones; slope.	Moderate: small stones.
Carey:				
CaB	Slight	Slight	Slight	Slight.
CaC, CaC2, CbD For Hinkle part of CbD, see Hinkle series.	Slight	Slight	Moderate: slope	Slight.
CeD3	Slight	Slight	Severe: slope	Slight.
Clairemont: Cm For Mangum part, see Mangum series.	Severe: floods	Moderate: floods	Severe: floods	Slight.
Cobb: CoB	Slight	Slight	Slight	Slight.
Cyril: Cy	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Devol: DeB	Moderate: too sandy	Moderate: too sandy	Moderate: slope	Moderate: too sandy.
Dill: DrE Rock outcrop part not rated.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Foard: FdA	Severe: percs slowly	Slight	Severe: percs slowly	Slight.
Gotebo: GbE, GcF Rock outcrop part of GcF not rated.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Grandfield:				
GnB	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
GrB	Slight	Slight	Slight	Slight.
Hardeman:				
HaB	Slight	Slight	Slight	Slight.
HaC	Slight	Slight	Moderate: slope	Slight.
HaD	Slight	Slight	Severe: slope	Slight.
Hinkle Mapped only with Carey, St. Paul, and Tillman soils.	Severe: percs slowly	Slight	Severe: percs slowly	Slight.
Hollister:				
HoA	Moderate: too clayey; percs slowly.	Moderate: too clayey	Moderate: too clayey; percs slowly.	Moderate: too clayey.
HoB, HoB2	Moderate: too clayey; percs slowly.	Moderate: too clayey	Moderate: too clayey; percs slowly; slope.	Moderate: too clayey.
Indiahoma: InB, InC	Severe: percs slowly	Moderate: too clayey	Severe: percs slowly	Moderate: too clayey.
Lawton:				
LaB, LaC, LaC2	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
LaD, LbE Rock outcrop part of LbE not rated.	Moderate: percs slowly.	Slight	Severe: slope	Slight.
Lincoln:				
Ln	Severe: floods	Moderate: floods	Moderate: floods	Moderate: floods.
Lo	Severe: floods	Severe: floods	Severe: floods	Severe: floods.

TABLE 4.—*Degree and kind of limitations for recreational uses—Continued*

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lugert: Lu	Severe: floods	Moderate: floods	Moderate: floods	Slight.
McLain: Mc	Severe: floods	Moderate: floods	Moderate: floods; percs slowly.	Moderate: too clayey.
Mangum Mapped only with Clairemont and Vernon soils.	Severe: floods; percs slowly; too clayey.	Severe: too clayey; floods.	Severe: too clayey; percs slowly; floods.	Severe: too clayey; floods.
Meno: MeB	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Miller: Mr, Ms	Severe: percs slowly; too clayey; floods.	Severe: too clayey	Severe: percs slowly	Severe: too clayey.
Natrustalfs: Na	Severe: percs slowly	Moderate: wet	Severe: percs slowly	Slight.
Port: Po	Severe: floods	Moderate: floods	Moderate: floods	Moderate: too clayey.
Pratt Mapped only with Tivoli soils.	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Reinach: Re	Severe: floods	Moderate: floods	Moderate: floods	Slight.
Rock outcrop: Rk, RoF. Too variable to rate; for Brico part of RoF, see Brico series.				
Roscoe: Rs	Severe: percs slowly; too clayey.	Severe: too clayey	Severe: too clayey; percs slowly.	Severe: too clayey.
St. Paul				
SaA, SbA	Slight	Slight	Slight	Slight.
SaB For Hinkle part of SbA, see Hinkle series.	Slight	Slight	Moderate: slope	Slight.
Shellabarger: ShC	Slight	Slight	Moderate: slope	Slight.
Somervell: SoF	Severe: small stones; slope.	Severe: small stones; slope.	Severe: small stones; slope.	Severe: small stones; slope.
Talpa:				
TaC	Slight	Slight	Moderate: slope	Slight.
TbF Rock outcrop part of TbF not rated.	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Tillman: TcB, TcC, TdB, ToC2 For Hinkle part of TdB, see Hinkle series; for Vernon part of ToC2, see Vernon series.	Moderate: too clayey; percs slowly.	Moderate: too clayey	Moderate: too clayey; slope.	Moderate: too clayey.
Tivoli: TpF For Pratt part, see Pratt series.	Severe: too sandy; dusty.	Severe: too sandy; dusty.	Severe: too sandy; dusty.	Severe: too sandy; dusty.
Tobosa: TsA	Severe: too clayey; percs slowly.	Severe: too clayey	Severe: too clayey; percs slowly.	Severe: too clayey.
Vernon:				
VeC, VmE For Mangum part of VmE, see Mangum series.	Severe: percs slowly	Moderate: too clayey	Severe: percs slowly	Moderate: too clayey.
VrE, VsE Rock outcrop part of VrE not rated.	Severe: percs slowly; too clayey.	Severe: too clayey	Severe: percs slowly; too clayey.	Severe: too clayey.
Yahola: Ya	Severe: floods	Moderate: floods	Severe: floods	Slight.

limited vehicular traffic. The best soils have mild slopes, good drainage, a surface free of rocks and coarse fragments, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry.

Picnic areas are attractive natural or landscaped tracts used mainly for preparing meals and eating outdoors. These areas are subject to heavy foot traffic. Most of the vehicular traffic, however, is confined to access roads. The best soils are firm when wet but not dusty when dry, are free of flooding during the season of use, and do not have slopes or stoniness that greatly increases the cost of leveling sites or of building access roads.

Playgrounds are areas used intensively for baseball, football, badminton, and similar organized games. Soils suitable for this use need to withstand intensive foot traffic. The best soils have a nearly level surface free of coarse fragments and rock outcrops, good drainage, freedom from flooding during periods of heavy use, and a surface that is firm after rain but not dusty when dry. If grading and leveling are required, depth to rock is important.

Paths and trails are used for local and cross-country travel by foot or on horseback. Design and layout should require little or no cutting and filling. The best soils are at least moderately well drained, are firm when wet but not dusty when dry, are flooded no more than once during the season of use, have slopes of less than 15 percent, and have few or no rocks or stones on the surface.

Engineering Uses of the Soils[7]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the properties of soils that are highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect the construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 5, 6, and 7, which show, respectively, estimates of several soil properties significant in engineering, interpretations for various engineering uses, and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those shown in tables 4 and 6, and it also can be used to make other useful maps.

This information, however, does not eliminate the need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths of more than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have different meanings in soil science than in engineering. The Glossary defines many of these terms as they are commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*2*), used by the Soil Conservation Service, Department of Defense, and other agencies, and the AASHTO system (*1*), adopted by the American Association of State Highway and Transportation Officials.

In the Unified system soils are classified according to particle-size distribution, plasticity, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL–ML.

The AASHTO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system a soil is placed in one of seven basic groups that range from A–1 to A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further break-

[7] WILLIAM E. HARDESTY, civil engineer, Soil Conservation Service, helped to prepare this section.

down, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b; A–2–4, A–2–5, A–2–6, A–2–7; and A–7–5, A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHTO classification for tested soils, with group index numbers in parentheses, is shown in table 7; the estimated classification, without group index numbers, is shown in table 5 for all soils mapped in the county.

Soil properties significant in engineering

Several soil properties significant in engineering are estimated in table 5. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other countries. Following are explanations of some of the columns in table 5.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 5 in the standard terms used by the United States Department of Agriculture (USDA). These terms take into account the relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semi-solid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semi-solid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 5, but in table 7 the data on liquid limit and plasticity index are based on tests of soil samples.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 5 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It commonly is defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and terms used to describe soil reaction are explained in the Glossary.

Salinity refers to the amount of soluble salts in the soil. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25°C. Salinity affects the suitability of a soil for crop production, its stability when used as construction material, and its corrosiveness to metals and concrete.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it loses water or swells as it gains water. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or of material that has this rating.

Corrosivity, as used in table 5, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. Rate of corrosion of uncoated steel is related to such soil properties as drainage, texture, total acidity, and electrical conductivity of the soil material. Corrosivity for concrete is influenced mainly by the content of sodium or magnesium sulfate, but also by soil texture and acidity. Installations of uncoated steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations made entirely in one kind of soil or in one soil horizon. A corrosivity rating of *low* means that there is a low probability of soil-induced corrosion damage. A rating of *high* means that there is a high probability of damage, so that protective measures for steel and more resistant concrete should be used to avoid or minimize damage.

Engineering interpretations

The interpretations in table 6 are based on the estimated engineering properties of soils shown in table 5, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Kiowa County. In table 6, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than drainage for crops and pasture, irrigation, and terraces and diversions. For these particular uses, table 6 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, severe, and very severe. *Slight* means that soil properties are generally favorable for the rated use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, spe-

TABLE 5.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table.

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				*Pct*
*Albion: AsE	>60	>6	0–12	Gravelly sandy loam	SM, GM, ML	A–4	
For Shellabarger part, see Shellabarger series.			12–36	Gravelly loam, gravelly sandy loam.	GM, GC, SM, SC, CL, ML, CL–ML	A–4	
			36–50	Gravelly sandy loam, gravelly loamy sand.	GM, SM, ML	A–1, A–2, A–3, A–4	
			50–65	Sand, gravelly sand	GM, SM	A–1, A–3	
Altus: AtA, AtB	>60	>6	0–17	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			17–65	Fine sandy loam, very fine sandy loam, loam, sandy clay loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
Brico: BrE	>60	>6	0–5	Cobbly loam	GC, SC, CL	A–4, A–6	2–30
			5–11	Loam, gravelly loam, cobbly loam.	CL, SC, GC	A–4, A–6	2–35
			11–40	Cobbly clay loam, cobbly clay, very cobbly clay.	GC, SC	A–2, A–6, A–7	7–40
			40–72	Cobbly clay loam, very cobbly clay loam.	GC	A–2, A–6, A–7	15–60
*Carey:							
CaB, CaC, CaC2, CbD	>60	>6	0–14	Silt loam	CL, ML, CL–ML	A–4	
For Hinkle part of CbD see Hinkle series.			14–48	Silt loam, clay loam, silty clay loam.	CL, ML	A–4, A–6	
			48–65	Loam, silt loam	CL, ML, CL–ML	A–4	
CeD3	>60	>6	0–14	Silt loam, silty clay loam	CL, ML, CL–ML	A–4	
			14–48	Silt loam, clay loam, silty clay loam.	CL, ML	A–4, A–6	
			48–65	Loam, silt loam	CL, ML, CL–ML	A–4	
*Clairemont: Cm	>60	>6	0–75	Silt loam, silty clay loam	CL–ML	A–4, A–6	
For Mangum part, see Mangum series.							
Cobb: CoB	20–40	>6	0–12	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			12–32	Sandy clay loam	CL–SC	A–4, A–6	
			32	Sandstone.			
Cyril: Cy	>60	>6	0–21	Loam	ML, CL–ML	A–4	
			21–60	Loam, fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
Devol: DeB	>60	>6	0–14	Loamy fine sand	SM	A–2	
			14–36	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			36–60	Fine sandy loam, loamy fine sand.	SM, ML, SC, CL, SM–SC, CL–ML	A–2, A–4	
			60–72	Loamy fine sand	SM	A–2	
Dill: DrE	20–40	>6	0–30	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
Rock outcrop part not estimated.			30–42	Sandstone.			
Foard: FdA	>60	>6	0–6	Silt loam	CL, ML	A–4, A–6	
			6–65	Silty clay loam, silty clay, clay.	CL, CH	A–6, A–7	
Gotebo: GbE, GcF	20–40	>6	0–6	Loam	CL, ML, CL–ML	A–4	
Rock outcrop part of GcF not estimated.			6–30	Loam, silt loam	CL, ML, CL–ML	A–4	
			30–32	Siltstone, shale.			

See footnote at end of table.

significant in engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for
The symbol < means less than; the symbol > means more than]

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in*	*pH*	*Mmhos*			
70–85	70–85	65–80	36–60	<25	[1]NP–4	2.0–6.0	0.02–0.12	5.6–6.5	-------	Low-------	Low-------	Low.
55–75	55–75	55–75	36–75	<31	NP–10	2.0–6.0	0.11–0.14	6.1–8.4	-------	Low-------	Low-------	Low.
45–70	45–70	45–70	5–60	<25	NP–4	2.0–6.0	0.06–0.09	6.1–8.4	-------	Low-------	Low-------	Low.
45–70	45–70	45–70	5–20	-------	NP	6.0–20	0.02–0.06	6.1–8.4	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–60	<30	NP–10	2.0–6.0	0.11–0.15	6.1–7.3	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–65	<31	NP–10	0.6–2.0	0.11–0.20	6.6–8.4	-------	Low-------	Low-------	Low.
65–85	65–85	60–80	40–60	30–37	10–15	0.6–2.0	0.10–0.15	6.1–7.3	-------	Low-------	Low-------	Low.
65–85	65–85	60–80	40–60	30–36	10–15	0.6–2.0	0.10–0.15	6.1–7.3	-------	Low-------	Low-------	Low.
40–70	40–70	30–60	30–50	37–65	16–37	0.2–0.6	0.04–0.13	6.1–7.3	-------	Moderate---	Moderate---	Low.
40–60	40–60	30–50	30–50	33–49	13–25	0.2–0.6	0.04–0.13	6.1–7.3	-------	Moderate---	Moderate---	Low.
100	100	96–100	80–97	22–31	2–8	0.6–2.0	0.16–0.24	6.6–7.8	-------	Low-------	Low-------	Low.
100	100	96–100	80–98	30–40	8–18	0.6–2.0	0.15–0.24	6.6–8.4	-------	Moderate---	Moderate---	Low.
100	100	96–100	65–97	22–31	2–10	0.6–2.0	0.15–0.24	7.9–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	65–97	22–31	2–10	0.6–2.0	0.15–0.24	6.6–7.8	-------	Low-------	Low-------	Low.
100	100	96–100	80–98	30–40	8–18	0.6–2.0	0.15–0.24	6.6–8.4	-------	Low-------	Moderate---	Low.
100	100	96–100	65–97	22–31	2–10	0.6–2.0	0.15–0.24	7.9–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	80–98	30–40	8–18	0.6–2.0	0.16–0.22	7.9–8.4	-------	Low-------	Moderate---	Low.
100	98–100	94–100	36–60	<30	NP–10	2.0–6.0	0.11–0.15	6.1–7.3	-------	Low-------	Low-------	Low.
100	100	90–100	36–65	25–37	7–16	0.6–2.0	0.12–0.17	6.1–8.4	-------	Low-------	Moderate---	Low.
100	100	96–100	36–65	23–31	3–10	0.6–2.0	0.15–0.20	7.4–8.4	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–65	<31	NP–10	0.6–2.0	0.11–0.20	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	90–100	15–35	-------	NP	2.0–6.0	0.07–0.11	6.6–7.3	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–60	<30	NP–10	2.0–6.0	0.11–0.15	7.4–7.8	-------	Low-------	Low-------	Low.
100	98–100	90–100	15–60	<30	NP–10	2.0–6.0	0.07–0.11	7.4–7.8	-------	Low-------	Low-------	Low.
100	98–100	90–100	15–35	-------	NP	2.0–6.0	0.07–0.11	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–60	30	NP–10	2.0–6.0	0.11–0.15	6.6–7.3	-------	Low-------	Low-------	Low.
100	100	96–100	80–97	30–37	8–13	0.6–2.0	0.16–0.22	6.6–7.8	-------	Low-------	High-------	High.
100	100	96–100	90–99	37–65	15–35	<0.06	0.10–0.15	7.4–8.4	2.6	High-------	High-------	High.
100	100	96–100	65–85	22–31	3–10	0.6–2.0	0.15–0.20	6.6–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	65–97	22–31	2–10	0.6–2.0	0.15–0.24	7.4–9.0	-------	Low-------	Low-------	Low.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				*Pct*
Grandfield:							
GnB	>60	>6	0–12	Loamy fine sand	SM	A–2	
			12–50	Fine sandy loam, sandy clay loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			50–70	Loamy fine sand, fine sand, fine sandy loam.	SP–SM, SM, ML, SC, CL, SM–SC, CL–ML	A–2, A–4	
GrB	>60	>6	0–12	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			12–50	Fine sandy loam, sandy clay loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			50–70	Loamy fine sand, fine sand, fine sandy loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–2, A–4	
Hardeman: HaB, HaC, HaD	>60	>6	0–7	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			7–65	Fine sandy loam, very fine sandy loam, loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
Hinkle Mapped only in complex with Carey, St. Paul, and Tillman soils.	>60	>6	0–7	Silt loam	CL, ML	A–4, A–6	
			7–65	Clay loam, silty clay loam.	CL	A–6, A–7	
Hollister: HoA, HoB, HoB2	>60	>6	0–10	Silty clay loam	CL	A–6, A–7	
			10–18	Clay loam, silty clay loam.	CL	A–6, A–7	
			18–85	Clay loam, silty clay loam, clay.	CL, CH	A–6, A–7	
			85–95	Shale.			
Indiahoma: InB, InC	>60	>6	0–13	Silty clay loam	CL	A–7	
			13–43	Silty clay, clay	CL, CH	A–7	
			43–60	Clay	CL–CH	A–7	
Lawton: LaB, LaC, LaC2, LaD, LbE. Rock outcrop part of LbE not estimated.	>60	>6	0–9	Loam	CL, ML, CL–ML	A–4	
			9–14	Clay loam, loam	CL	A–4, A–6	
			14–45	Clay loam	CL	A–6, A–7	
			45–60	Loam, clay loam, sandy clay loam, gravelly loam, gravelly clay loam, gravelly sandy clay loam.	CL, GC, SC	A–2, A–4, A–6	
Lincoln:							
Ln	>60	>6	0–8	Loamy fine sand	SM	A–2	
			8–60	Loamy fine sand, fine sand.	SM, SP–SM	A–2, A–3	
Lo	>60	>6	0–8	Loamy fine sand, fine sandy loam, loam, clay loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–2, A–4, A–6	
			8–60	Loamy fine sand, fine sand.	SM, SP–SM	A–2, A–3	
Lugert: Lu	>60	>6	0–10	Loam	CL, ML, CL–ML	A–4	
			10–65	Loam, silt loam, very fine sandy loam.	CL, ML, CL–ML	A–4	
Mangum Mapped only with Clairemont and Vernon soils.	>60	>6	0–60	Silty clay, clay	CL, CH	A–7	
McLain: Mc	>60	>6	0–15	Silty clay loam	CL	A–6, A–7	
			15–36	Silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	

See footnote at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in*	*pH*	*Mmhos*			
100	98–100	90–100	15–35	-------	NP	2.0–6.0	0.07–0.11	6.6–7.8	-------	Low-------	Low-------	Low.
100	98–100	90–100	36–65	31	NP–10	0.6–2.0	0.11–0.17	7.4–8.4	-------	Low-------	Moderate---	Low.
100	98–100	82–100	15–60	30	NP–10	2.0–6.0	0.05–0.15	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–60	30	NP–10	2.0–6.0	0.11–0.15	6.6–7.8	-------	Low-------	Low-------	Low .
100	98–100	90–100	36–65	31	NP–10	0.6–2.0	0.11–0.17	7.4–8.4	-------	Low-------	Moderate---	Low.
100	98–100	82–100	15–60	30	NP–10	2.0–6.0	0.05–0.15	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–60	30	NP–10	2.0–6.0	0.11–0.15	7.4–7.8	-------	Low-------	Low-------	Low.
100	98–100	94–100	36–75	31	NP–10	2.0–6.0	0.11–0.20	7.9–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	80–97	30–37	8–13	0.6–2.0	0.16–0.20	6.1–8.4	-------	Low-------	High-------	High.
100	100	96–100	80–98	37–50	16–25	<0.06	0.09–0.17	7.4–8.4	---2.6	High-------	High-------	High.
100	100	98–100	90–98	33–42	12–19	0.2–0.6	0.18–0.22	7.4–7.8	-------	Moderate---	Moderate---	Low.
100	100	96–100	80–98	33–42	12–20	0.06–0.2	0.15–0.22	7.9–8.4	-------	High-------	High-------	Low.
100	100	96–100	80–98	37–60	15–33	0.06–0.2	0.12–0.22	7.9–8.4	-------	High-------	High-------	Low.
100	100	98–100	90–98	41–50	18–26	0.06–0.2	0.18–0.22	6.6–7.8	-------	Moderate---	Moderate---	Low.
100	100	96–100	90–99	41–65	18–38	<0.06	0.12–0.18	7.4–8.4	-------	High-------	High-------	Low.
100	100	96–100	90–95	45–65	21–38	<0.06	0.12–0.18	7.9–8.4	-------	High-------	High-------	Low.
100	100	96–100	65–85	22–31	3–10	0.6–2.0	0.15–0.20	6.1–7.3	-------	Low-------	Low-------	Low.
90–100	85–98	85–98	50–90	30–40	9–18	0.6–2.0	0.14–0.20	6.1–7.3	-------	Moderate---	Moderate---	Low.
90–100	85–98	85–98	60–90	34–43	13–20	0.2–0.6	0.14–0.20	6.6–8.4	-------	Moderate---	Moderate---	Low.
50–98	50–98	50–98	25–90	30–43	9–20	0.6–2.0	0.05–0.20	6.6–8.4	-------	Moderate---	Moderate---	Low.
100	98–100	90–100	15–35	-------	NP	6.0–20	0.07–0.11	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	82–100	5–35	-------	NP	6.0–20	0.05–0.11	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	90–100	15–90	<40	NP–18	6.0–20	0.05–0.20	7.9–8.4	-------	Low-------	Low-------	Low.
100	98–100	82–100	5–35	-------	NP	6.0–20	0.05–0.11	7.9–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	65–85	22–31	3–10	0.6–2.0	0.15–0.20	6.6–7.8	-------	Low-------	Low-------	Low.
100	100	94–100	51–95	<30	NP–10	0.6–2.0	0.13–0.24	6.6–8.4	-------	Low-------	Low-------	Low.
100	100	96–100	90–99	41–65	18–38	<0.06	0.12–0.18	7.9–8.4	-------	High-------	High-------	Low.
100	100	98–100	90–98	33–42	12–19	0.2–0.6	0.18–0.22	6.1–7.8	-------	Moderate---	High-------	Low.
100	100	96–100	80–99	37–65	15–35	0.06–0.2	0.12–0.22	7.4–8.4	-------	High-------	High-------	Low.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				*Pct*
McLean: Continued			36–60	Silty loam, loam, silty clay loam, clay loam, silty clay.	CL, CH	A–6, A–7	-------
Meno: MeB	>60	2–3	0–21	Loamy fine sand	SM	A–2	-------
			21–60	Fine sandy loam, sandy loam, sandy clay loam.	SM, ML, SC, CL SM–SC, CL–ML	A–4, A–6	-------
			60–84	Loam, fine sandy loam, sandy clay loam.	SM, ML, SC, CL, SM–SC, CL–ML	A–4, A–6	-------
Miller:							
Mr	>60	>6	0–10	Clay	CL, CH	A–7	-------
			10–72	Silty clay loam, clay loam, silty clay, clay.	CL, CH	A–6, A–7	-------
Ms	>60	>6	0–10	Loam, silt loam, silty clay loam, silty clay, clay.	CL, ML, CH	A–6, A–7	-------
			10–72	Silty clay loam, clay loam, silty clay, clay.	CL, CH	A–6, A–7	-------
Natrustalfs: Na	>60	>6	0–7	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	-------
			7–14	Loam, silt loam	CL, ML	A–4, A–6	-------
			14–72	Clay loam, silty clay loam.	CL	A–6, A–7	-------
Port: Po	>60	>6	0–26	Silty clay loam	CL	A–6, A–7	-------
			26–65	Silt loam, loam, silty clay loam.	ML, CL	A–4, A–6, A–7	-------
Pratt Mapped only with Tivoli soils.	>60	>6	0–42	Loamy fine sand	SM	A–2	-------
			42–60	Fine sand	SM, SP–SM	A–2, A–3	-------
Reinach: Re	>60	>6	0–38	Loam	CL, ML, CL–ML	A–4	-------
			38–72	Loam, silt loam, very fine sandy loam.	CL, ML, CL–ML	A–4	-------
*Rock outcrop: Rk, RoF. Too variable to estimate; for Brico part of RoF, see Brico series.							
Rcscoe: Rs	>60	>6	0–80	Clay	CL, CH	A–7	-------
*St. Paul: SaA, SaB, SbA For Hinkle part of SbA, see Hinkle series.	>60	>6	0–9	Silt loam	CL, ML, CL–ML	A–4, A–6	-------
			9–16	Silty clay loam, silt loam	CL	A–4, A–6	-------
			16–42	Clay loam, silty clay loam.	CL, CH	A–6, A–7	-------
			42–65	Loam, silt loam, clay loam, silty clay loam.	CL	A–4, A–6, A–7	-------
Shellabarger: ShC	>60	>6	0–20	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	-------
			20–48	Sandy clay loam	CL, SC	A–4, A–6	-------
			48–65	Sandy loam, sandy clay loam.	ML, SM, CL, SC	A–4, A–6	-------
Somervell: SoF	20–40	>6	0–11	Cobbly loam	GM–GC	A–4, A–6	50–60
			11–34	Cobbly clay loam	GM, GC	A–6, A–7	50–60
			34	Limestone.			
Talpa: TaC, TbF Rock outcrop part of TbF not estimated.	5–14	>6	0–9	Loam	CL, ML	A–4, A–6	-------
			9–14	Limestone.			

See footnote at end of table.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in*	*pH*	*Mmhos*			
100	95–100	95–100	65–99	35–65	13–38	0.06–0.2	0.12–0.24	7.9–8.4		High	High	Low.
100	98–100	90–100	15–35		NP	6.0–20	0.07–0.11	5.6–7.3		Low	Moderate	Moderate.
100	98–100	90–100	36–65	<37	NP–16	0.6–2.0	0.10–0.17	6.1–6.5		Low	Moderate	Moderate.
100	98–100	96–100	36–85	<37	NP–16	0.6–2.0	0.11–0.20	6.1–6.5		Low	Moderate	Moderate.
100	100	96–100	90–95	45–65	22–38	<0.06	0.12–0.18	7.4–8.4		High	High	Low.
100	100	96–100	80–98	37–65	15–38	<0.06	0.12–0.22	7.4–8.4		High	High	Low.
100	100	96–100	65–98	35–65	13–38	0.06–0.2	0.10–0.15	7.4–8.4	4–10	Low	High	Low.
100	100	96–100	80–98	37–65	15–35	<0.06	0.08–0.15	7.4–8.4	4–10	High	High	Moderate.
100	98–100	94–100	36–60	<30	NP–10	2.0–6.0	0.11–0.15	6.1–8.4		Low	High	High.
100	100	96–100	65–97	30–37	8–14	0.6–2.0	0.08–0.15	6.1–8.4	2–6	Low	High	High.
100	100	96–100	80–98	33–43	12–20	<0.06	0.07–0.15	7.4–8.4	2–6	Moderate	High	High.
100	100	98–100	90–98	33–42	12–19	0.6–2.0	0.18–0.22	6.6–7.8		Moderate	Low	Low.
100	100	96–100	65–98	30–42	9–19	0.6–2.0	0.15–0.22	7.4–8.4		Moderate	Low	Low.
100	98–100	90–100	15–35		NP	6.0–20	0.07–0.11	5.6–7.3		Low	Low	Low.
100	98–100	82–98	5–25		NP	6.0–20	0.05–0.08	6.6–7.3		Low	Low	Low.
100	100	96–100	65–85	22–31	3–10	0.6–2.0	0.15–0.20	6.6–8.4		Low	Low	Low.
100	100	94–100	51–97	<31	NP–10	0.6–2.0	0.13–0.24	7.9–8.4		Low	Low	Low.
100	100	96–100	90–95	45–70	19–38	<0.06	0.12–0.18	6.6–8.4		High	High	Low.
100	100	96–100	80–97	21–35	2–13	0.6–2.0	0.16–0.24	6.6–7.8		Low	Low	Low.
100	100	95–100	75–98	30–40	8–18	0.6–2.0	0.17–0.21	6.6–7.3		Low	Moderate	Low.
100	95–100	95–100	72–98	30–55	11–30	0.2–0.6	0.17–0.21	7.4–8.4		Moderate	Moderate	Low.
100	95–100	94–100	70–96	27–45	8–22	0.6–2.0	0.17–0.21	7.4–8.4		Low	Moderate	Low.
100	98–100	94–100	36–60	<30	NP–10	0.6–2.0	0.11–0.15	5.6–7.3		Low	Low	Low.
100	100	90–100	36–65	25–36	7–16	0.6–2.0	0.12–0.17	7.9–8.4		Low	Low	Low.
100	98–100	90–100	36–65	<37	NP–16	0.6–2.0	0.10–0.17	7.4–8.4		Low	Low	Low.
50–60	50–60	40–50	40–50	30–37	9–14	0.6–2.0	0.05–0.10	7.9–8.4		Low	High	Low.
50–60	50–60	40–50	40–50	34–43	13–20	0.6–2.0	0.05–0.10	7.9–8.4		Low	High	Low.
100	100	96–100	65–85	30–37	9–14	0.6–2.0	0.12–0.16	7.9–8.4		Low	High	Low.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to—		Depth from surface	USDA texture	Classification		Coarse fraction greater than 3 inches
	Bedrock	Seasonal high water table			Unified	AASHTO	
	In	*Ft*	*In*				*Pct*
*Tillman: TcB, TcC, TdB, ToC2—For Hinkle part of TdB, see Hinkle series; for Vernon part of ToC2, see Vernon series.	>60	>6	0–11	Clay loam	CL	A–4, A–6	
			11–65	Clay loam, clay	CL, CH	A–6, A–7	
			65–95	Clay loam, clay, shaly clay.	CL, CH	A–6, A–7	0–5
*Tivoli: TpF—For Pratt part, see Pratt series.	>60	>6	0–6	Loamy fine sand	SM	A–2	
			6–60	Fine sand	SM, SP–SM	A–2, A–3	
Tobosa: TsA	>60	>6	0–24	Clay	CH	A–7	
			24–60	Silty clay, clay	CL, CH	A–7	
*Vernon:							
VeC, VmE—For Mangum part of VmE, see Mangum series.	>60	>6	0–7	Clay loam	CL	A–6, A–7	
			7–29	Silty clay, clay	CL, CH	A–7	
			29–60	Shaly clay	CL, CH	A–7	
VrE—Rock outcrop part, not estimated.	>60	>6	0–29	Clay	CL, CH	A–7	
			29–60	Shaly clay	CL, CH	A–7	
VsE	>60	>6	0–7	Clay loam, clay	CL, CH	A–6, A–7	
			7–29	Silty clay, clay	CL, CH	A–7	
			29–60	Shaly clay	CL, CH	A–7	
Yahola: Ya	>60	>6	0–14	Fine sandy loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	
			14–72	Fine sandy loam, loam	SM, ML, SC, CL, SM–SC, CL–ML	A–4	

[1] NP = nonplastic.

TABLE 6.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table. "Shrink-swell," "floods," and other terms that describe restrictive

Soil series and map symbols	Suitability as source of—			Degree and kind of limitations for—		
	Road fill	Sand and gravel	Topsoil	Septic tank absorption fields	Sewage lagoons	Shallow excavations
*Albion: AsE—For Shellabarger part, see Shellabarger series.	Good	Good for sand below a depth of 50 inches.	Fair: slope	Moderate: slope.	Severe: seepage.	Moderate: small stones.
Altus:						
AtA	Fair: low strength.	Unsuited: excess fines.	Good	Slight	Moderate: seepage.	Slight
AtB	Fair: low strength.	Unsuited: excess fines.	Good	Slight	Moderate: slope; seepage.	Slight
Brico: BrE	Fair: shrink-swell.	Unsuited: excess fines.	Poor: small stones; slope.	Severe: percs slowly; slope.	Severe: slope	Severe: too clayey; slope.

significant in engineering—Continued

Percentage less than 3 inches passing sieve—				Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Corrosivity	
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)								Uncoated steel	Concrete
				Pct		*In per hr*	*In per in*	*pH*	*Mmhos*			
100	100	96–98	80–90	31–40	10–18	0.2–0.6	0.15–0.20	6.6–7.3		Moderate	High	Low.
100	100	96–98	80–95	39–55	17–30	0.06–0.2	0.15–0.20	7.9–8.4		High	High	Low.
90–100	85–100	80–90	60–95	39–55	17–30	0.06–0.2	0.13–0.17	7.9–8.4		Moderate	High	Low.
100	98–100	90–100	15–35		NP	6.0–20	0.07–0.11	6.1–7.8		Low	Low	Low.
100	98–100	82–98	5–25		NP	6.0–20	0.05–0.08	6.1–8.4		Low	Low	Low.
100	100	96–100	90–95	45–65	19–35	<0.06	0.12–0.18	7.9–8.4		High	High	Low.
100	100	96–100	90–95	41–60	18–32	<0.06	0.12–0.16	7.9–8.4		High	High	High.
100	100	96–100	80–90	37–50	16–26	<0.06	0.15–0.20	7.9–8.4		High	High	Low.
100	100	96–100	90–99	41–60	18–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
90–100	85–100	65–100	65–90	45–60	19–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
100	100	96–100	90–95	45–60	19–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
90–100	85–100	65–100	65–90	45–60	19–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
100	100	96–100	80–95	37–60	16–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
100	100	96–100	90–99	41–60	18–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
90–100	85–100	65–100	65–90	45–60	19–32	<0.06	0.12–0.17	7.9–8.4		High	High	Low.
100	98–100	94–100	36–60	<30	NP–10	2.0–6.0	0.11–0.15	7.9–8.4		Low	Low	Low.
100	98–100	94–100	36–85	<31	NP–10	2.0–6.0	0.11–0.20	7.9–8.4		Low	Low	Low.

interpretations

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," and other terms used to rate the soils]

Degree and kind of limitations for—Continued					Soil features affecting—		
Dwellings without basements	Sanitary landfill (trench)	Local roads and streets	Pond reservoir areas	Pond embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Moderate: slope.	Severe: seepage.	Moderate: slope.	Severe: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Fast intake; seepage.	Erodes easily; piping.
Moderate: low strength.	Slight	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; piping; compressible.	Well drained	Erodes easily	Piping.
Moderate: low strength.	Slight	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; piping; compressible.	Well drained	Erodes easily	Piping.
Moderate: shrink-swell; slope.	Severe: too clayey.	Moderate: shrink-swell; slope.	Moderate: seepage.	Slight	Well drained	Slow intake; slope; small stones.	Percs slowly; slope; small stones.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—			Degree and kind of limitations for—		
	Road fill	Sand and gravel	Topsoil	Septic tank absorption fields	Sewage lagoons	Shallow excavations
*Carey: CaB, CaC, CaC2, CbD— For Hinkle part of CbD, see Hinkle series.	Fair: low strength; shrink-swell.	Poor: excess fines.	Fair: too clayey; thin layer.	Moderate: percs slowly.	Moderate: seepage.	Slight
CeD3	Fair: low strength; shrink-swell.	Poor: excess fines.	Fair: too clayey; thin layer.	Moderate: percs slowly.	Severe: slope	Slight
*Clairemont: Cm— For Mangum part, see Mangum series.	Fair: low strength.	Unsuited: excess fines.	Fair: too clayey.	Severe: floods	Severe: floods	Severe: floods
Cobb: CoB	Fair: low strength.	Unsuited: excess fines.	Good	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Cyril: Cy	Fair: low strength.	Unsuited: excess fines.	Good	Severe: floods	Severe: floods	Severe: floods
Devol: DeB	Good	Poor for sand: excess fines. Unsuited to gravel: excess fines.	Poor: too sandy.	Slight	Severe: seepage.	Slight
Dill: DrE— Rock outcrop part not rated.	Fair: thin layer.	Unsuited: excess fines.	Fair: slope	Severe: depth to rock.	Severe: seepage; depth to rock; slope.	Moderate: depth to rock.
Foard: FdA	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Poor: too clayey.	Severe: percs slowly.	Slight	Severe: too clayey.
Gotebo:						
GbE	Fair: low strength.	Unsuited: excess fines.	Moderate: slope.	Severe: depth to rock.	Severe: depth to rock; slope.	Moderate: slope; depth to rock.
GcF— Rock outcrop part of GcF not rated.	Fair: low strength.	Unsuited: excess fines.	Severe: slope	Severe: depth to rock; slope.	Severe: depth to rock; slope.	Severe: slope
Grandfield:						
GnB	Fair: low strength.	Unsuited: excess fines.	Poor: too sandy.	Slight	Moderate: slope.	Slight
GrB	Fair: low strength.	Unsuited: excess fines.	Good	Slight	Moderate: slope.	Slight
Hardeman: HaB, HaC, HaD.	Fair: low strength.	Unsuited: excess fines.	Good	Slight	Severe: seepage.	Slight
Hinkle— Mapped only with Carey, St. Paul, and Tillman soils.	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Poor: thin layer.	Severe: percs slowly.	Slight	Severe: too clayey.
Hollister: HoA, HoB, HoB2.	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Fair: too clayey.	Severe: percs slowly.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 3 percent.	Severe: too clayey.

interpretations—Continued

Degree and kind of limitations for—					Soil features affecting—		
Dwellings without basements	Sanitary landfill (trench)	Local roads and streets	Pond reservoir areas	Pond embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Moderate: low strength; shrink-swell.	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Erodes easily	Piping; erodes easily.
Moderate: low strength; shrink-swell.	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Moderate: seepage.	Moderate: unstable fill; piping; compressible.	Well drained	Erodes easily	Piping; erodes easily.
Severe: floods	Severe: floods.	Severe: floods	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained; floods.	Floods	Piping.
Moderate: low strength.	Severe: depth to rock.	Moderate: low strength; depth to rock.	Moderate: seepage.	Moderate: unstable fill; compressible; piping; thin layer.	Well drained; depth to rock.	Rooting depth; droughty.	Depth to rock; droughty; piping.
Severe: floods	Severe: floods.	Severe: floods	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained; floods.	Floods	Piping.
Slight	Severe: seepage.	Slight	Severe: seepage.	Moderate: unstable fill; piping.	Well drained	Seepage; fast intake.	Erodes easily; piping.
Moderate: slope.	Severe: seepage.	Moderate: slope.	Severe: seepage.	Moderate: thin layer; unstable fill; piping.	Well drained; depth to rock.	Fast intake; rooting depth; seepage; droughty.	Rooting depth; erodes easily; slopes depth to rock.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible.	Percs slowly; excess salts.	Percs slowly; excess salts.	Percs slowly; excess salts.
Moderate: depth to rock.	Moderate: depth to rock.	Moderate: low strength.	Severe: depth to rock.	Moderate: piping; compressible; unstable fill.	Well drained	Slope	Slope.
Severe: slope	Moderate: depth to rock.	Severe: slope	Severe: depth to rock.	Moderate: piping; compressible; unstable fill.	Well drained	Slope	Slope.
Slight	Slight	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; piping.	Well drained	Fast intake	Piping.
Slight	Slight	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Erodes easily.	Piping.
Moderate: low strength.	Severe: seepage.	Moderate: low strength.	Severe: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Seepage	Piping.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Severe: unstable fill; low strength.	Percs slowly; excess salts.	Percs slowly; excess salts.	Percs slowly; excess salts.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible; piping.	Well drained	Slow intake; percs slowly.	Percs slowly; droughty; piping; erodes easily.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—			Degree and kind of limitations for—		
	Road fill	Sand and gravel	Topsoil	Septic tank absorption fields	Sewage lagoons	Shallow excavations
Indiahoma: InB, InC	Poor: shrink-swell; low strength.	Unsuited: excess fines.	Fair: thin layer; too clayey.	Severe: percs slowly.	Slight where slopes are 1 to 2 percent. Moderate where slopes are 2 to 5 percent.	Severe: too clayey.
Lawton: LaB, LaC, LaC2, LaD, LbE. Rock outcrop part of LbE not rated.	Poor: low strength.	Unsuited to sand: excess fines. Unsuited to gravel above a depth of 45 inches, poor below: excess fines.	Fair: thin layer.	Severe: percs slowly.	Slight where slopes are 1 to 2 percent. Moderate where slopes are 2 to 8 percent.	Moderate: too clayey.
Lincoln:						
Ln	Good	Fair for sand: excess fines. Unsuited to gravel: excess fines.	Poor: too sandy.	Severe: floods	Severe: percs rapidly; floods.	Severe: floods; cutbanks cave.
Lo	Good	Fair for sand: excess fines. Unsuited to gravel: excess fines.	Fair: too sandy.	Severe: floods	Severe: percs rapidly; floods.	Severe: floods; cutbanks cave.
Lugert: Lu	Fair: low strength.	Unsuited: excess fines.	Good	Severe: floods	Severe: floods	Severe: floods
McLain: Mc	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Fair: thin layer.	Severe: percs slowly.	Slight	Severe: too clayey.
Mangum. Mapped only with Clairemont and Vernon soils.	Poor: shrink-swell; low strength.	Unsuited: excess fines.	Poor: too clayey.	Severe: percs slowly; floods.	Severe: floods	Severe: floods; too clayey.
Meno: MeB	Fair: low strength.	Unsuited: excess fines.	Poor: too sandy.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Miller:						
Mr	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Fair: thin layer.	Severe: percs slowly; floods.	Severe: floods	Severe: floods; too clayey.
Ms	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Fair: thin layer.	Severe: percs slowly; floods.	Severe: floods	Severe: floods; too clayey.
Natrustalfs: Na	Fair: low strength; shrink-swell.	Unsuited: excess fines.	Fair: thin layer.	Severe: percs slowly.	Slight	Moderate: too clayey; wetness.
Port: Po	Fair: low strength; shrink-swell.	Unsuited: excess fines.	Fair: too clayey.	Severe: floods	Severe: floods	Severe: floods
Pratt. Mapped only with Tivoli soils.	Good	Poor: excess fines.	Poor: too sandy.	Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent.	Severe: seepage.	Severe: too sandy.

interpretations—Continued

Degree and kind of limitations for—Continued					Soil features affecting—		
Dwellings without basements	Sanitary landfill (trench)	Local roads and streets	Pond reservoir areas	Pond embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Severe: piping; compressible; unstable fill.	Well drained; percs slowly.	Slow intake; percs slowly.	Percs slowly; droughty; piping.
Moderate: low strength; shrink-swell.	Moderate: too clayey.	Severe: low strength.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Slow intake	Piping.
Severe: floods	Severe: floods; seepage.	Severe: floods	Severe: seepage.	Moderate: unstable fill; piping.	Floods	Floods; seepage; fast intake.	Floods; piping.
Severe: floods	Severe: floods; seepage.	Severe: floods	Severe: seepage.	Moderate: unstable fill; piping.	Floods	Floods; seepage; fast intake.	Floods; piping.
Severe: floods	Severe: floods.	Moderate: low strength; floods.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained; floods.	Floods	Floods; piping.
Severe: floods; shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Severe: compressible; piping.	Percs slowly	Slow intake; percs slowly; floods.	Slow intake; piping; percs slowly.
Severe: floods; shrink-swell; low strength.	Severe: floods; too clayey.	Severe: floods; low strength; shrink-swell.	Slight	Severe: compressible; unstable fill.	Floods; percs slowly.	Floods; slow intake; percs slowly.	Floods; slow intake; percs slowly.
Moderate: wetness; low strength.	Severe: wetness.	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Poor outlets; wetness.	Seepage; fast intake; wetness.	Poor outlets; piping.
Severe: floods; shrink-swell; low strength.	Severe: floods; too clayey.	Severe: shrink-swell; low strength.	Slight	Moderate: unstable fill; compressible; shrink-swell.	Floods; percs slowly.	Floods; slow intake; percs slowly.	Percs slowly.
Severe: floods; too clayey.	Severe: floods; too clayey.	Severe: shrink-swell; low strength.	Slight	Moderate: unstable fill, compressible; shrink-swell.	Floods; excess salts; percs slowly.	Floods; excess salts; slow intake.	Percs slowly; excess salts.
Moderate: wetness; low strength.	Moderate: too clayey.	Moderate: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible; piping.	Excess salts; percs slowly.	Excess salts; percs slowly.	Percs slowly; excess salts; piping.
Severe: floods	Severe: floods.	Moderate: low strength; shrink-swell; floods.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained; floods.	Floods	Erodes easily; piping.
Slight where slopes are 3 to 8 percent. Moderate where slopes are 8 to 15 percent.	Severe: seepage.	Slight where slopes are 0 to 8 percent. Moderate where slopes are 8 to 15 percent.	Severe: seepage.	Moderate: unstable fill; piping.	Well drained; complex slope.	Complex slope; erodes easily; fast intake; seepage.	Complex slope; erodes easily; droughty; piping.

TABLE 6.—*Engineering*

Soil series and map symbols	Suitability as source of—			Degree and kind of limitations for—		
	Road fill	Sand and gravel	Topsoil	Septic tank absorption fields	Sewage lagoons	Shallow excavations
Reinach: Re	Fair: low strength.	Unsuited: excess fines.	Good	Moderate: floods.	Moderate: seepage.	Moderate: floods.
*Rock outcrop: Rk, RoF. Too variable to rate; for Brico part of RoF, see Brico series.						
Roscoe: Rs	Poor: low strength; shrink-swell.	Unsuited: excess fines.	Poor: too clayey.	Severe: percs slowly.	Slight	Severe: too clayey.
*St. Paul: SaA, SaB, SbA. For Hinkle part of SbA, see Hinkle series.	Poor: low strength.	Unsuited: excess fines.	Fair: thin layer.	Moderate: percs slowly.	Slight where slopes are 0 to 2 percent. Moderate where slopes are 2 to 3 percent.	Moderate: too clayey.
Shellabarger: ShC	Fair: low strength.	Unsuited: excess fines.	Good	Moderate: seepage.	Moderate: seepage.	Slight
Somervell: SoF	Fair: shrink-swell; low strength.	Poor: excess fines.	Poor: small stones; large stones.	Severe: depth to rock.	Severe: depth to rock; slope.	Severe: depth to rock; slope.
Talpa: TaC, TbF. Rock outcrop part of TbF not rated.	Poor: thin layer.	Unsuited: excess fines.	Poor: thin layer; area reclaim.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.
*Tillman: TcB, TcC, TdB, ToC2. For Hinkle part of TdB, see Hinkle series; for Vernon part of ToC2, see Vernon series.	Poor: shrink-swell; low strength.	Unsuited: excess fines.	Fair: too clayey; thin layer.	Severe: percs slowly.	Slight where slopes are 1 to 2 percent. Moderate where slopes are 2 to 5 percent.	Severe: too clayey.
*Tivoli: TpF. For Pratt part, see Pratt series.	Good	Fair for sand: excess fines. Unsuited to gravel: excess fines.	Poor: too sandy.	Moderate: slope.	Severe: seepage; slope.	Severe: too sandy; cutbanks cave.
Tobosa: TsA	Poor: shrink-swell; low strength.	Unsuited: excess fines.	Poor: too clayey.	Severe: percs slowly.	Slight	Severe: too clayey.
*Vernon: VeC, VmE, VrE, VsE. For Mangum part of VmE, see Mangum series; Rock outcrop part of VrE not rated.	Poor: shrink-swell; low strength.	Unsuited: excess fines.	Poor: too clayey; thin layer.	Severe: percs slowly.	Slight where slopes are 1 to 2 percent. Moderate where slopes are 2 to 7 percent. Severe where slopes are 7 to 12 percent.	Severe: too clayey.
Yahola: Ya	Fair: low strength.	Unsuited: excess fines.	Good	Severe: floods	Severe: seepage; floods.	Severe: floods

interpretations—Continued

Degree and kind of limitations for—Continued					Soil features affecting—		
Dwellings without basements	Sanitary landfill (trench)	Local roads and streets	Pond reservoir areas	Pond embankments	Drainage for crops and pasture	Irrigation	Terraces and diversions
Severe: floods	Moderate: floods.	Moderate: low strength; floods.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Floods	Piping; erodes easily.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: too clayey; shrink-swell.	Slight	Severe: unstable fill; compressible.	Percs slowly; poor outlets.	Percs slowly; slow intake.	Percs slowly.
Moderate: shrink-swell; low strength.	Moderate: too clayey.	Severe: low strength.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Erodes easily	Erodes easily; piping.
Moderate: low strength.	Slight	Moderate: low strength.	Moderate: seepage.	Moderate: unstable fill; compressible; piping.	Well drained	Erodes easily	Piping.
Moderate: slope.	Severe: depth to rock.	Moderate: depth to rock; slope.	Severe: depth to rock.	Moderate: unstable fill; piping; thin layer.	Well drained; depth to rock.	Rooting depth; droughty.	Depth to rock; droughty; piping.
Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock; thin layer.	Well drained; depth to rock.	Rooting depth; droughty.	Depth to rock; droughty.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible.	Well drained	Erodes easily	Erodes easily.
Moderate: slope.	Severe: seepage; too sandy.	Moderate: slope.	Severe: seepage.	Severe: unstable fill; piping.	Complex slope.	Complex slope; erodes easily; fast intake; seepage.	Complex slope; erodes easily; droughty; piping.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible.	Well drained; percs slowly.	Percs slowly; slow intake.	Percs slowly.
Severe: shrink-swell; low strength.	Severe: too clayey.	Severe: low strength; shrink-swell.	Slight	Moderate: unstable fill; compressible.	Well drained; percs slowly.	Percs slowly; slow intake.	Erodes easily; percs slowly.
Severe: floods	Severe: floods; seepage.	Moderate: floods; low strength.	Severe: seepage.	Moderate: unstable fill; piping.	Well drained; floods.	Floods; seepage.	Piping.

TABLE 7.—*Engineering*

[Tests performed by Oklahoma State

Soil name and location	Parent material	Report No. SO–	Depth	Shrinkage		Volume change
				Limit	Ratio	
			In	*Pct*		*Pct*
Carey silt loam:						
1,600 feet east and 700 feet north of southwest corner sec. 15, T. 3 N., R. 18 W. (Modal)	Silty sediment	7639	0–10	19	1.74	12
		7640	10–23	17	1.83	28
		7641	60–72	12	1.99	31
Devol loamy fine sand:						
800 feet west and 600 feet north of south quarter-corner sec. 12, T. 3 N., R. 19 W. (Modal)	Eolian sediment	7642	0–14	[1] NP	NP	NP
		7643	14–36	NP	NP	NP
		7644	60–72	NP	NP	NP
Hollister silty clay loam:						
1,000 feet south and 100 feet west of east quarter-corner sec. 10, T. 6 N., R. 17 W. (Modal)	Clayey sediment	7624	0–9	12	1.99	55
		7625	15–42	10	2.00	74
		7626	65–80	10	2.07	33
Lawton loam:						
100 feet north and 100 feet east of west quarter-corner sec. 24, T. 3 N., R. 17 W. (Modal)	Old alluvial sediment	7627	0–11	NP	NP	NP
		7628	15–30	12	1.98	51
		7629	48–60	18	1.75	27
Tillman silt loam:						
100 feet south and 100 feet east of northwest corner sec. 3, T. 5 N., R. 18 W. (Surface layer coarser textured than modal)	Old clayey alluvial sediment.	7621	0–9	15	1.79	17
		7622	15–27	10	2.04	59
		7623	56–72	12	2.02	41

[1] Mechanical analyses according to the AASHTO Designation T 88 (*1*). Results obtained by this procedure may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

cial design, or intensive maintenance. *Very severe* means that one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 6.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage, and the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 6 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is within a depth of 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or other factors that affect mining of the materials, nor do they indicate quality of the deposit.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as for preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and its content of stone fragments affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material between depths of 18 inches and 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope affects difficulty of layout and construction and also the risk of erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

test data

Department of Highways, Materials Division]

Mechanical analysis [1]							Liquid limit	Plasticity index	Classification	
Percentage passing seive—				Percentage smaller than—					AASHTO [2]	Unified [3]
No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 40 (0.42 mm)	No. 200 (0.074 mm)	0.05 mm	0.005 mm	0.002 mm				
							Pct			
----------	100	99	92	77	20	16	29	7	A-4(8)	CL-ML
----------	----------	100	94	78	30	25	37	15	A-6(10)	CL
----------	100	99	96	87	42	33	34	14	A-6(10)	CL
----------	100	91	16	7	4	3	----------	NP	A-2-3(0)	SM
----------	100	94	40	20	10	8	----------	NP	A-4(1)	SM
----------	100	95	18	7	5	4	----------	NP	A-2-3(0)	SM
----------	----------	----------	98	92	46	39	44	20	A-7-6(13)	CL
----------	100	99	98	92	52	46	68	42	A-7-6(20)	CH
----------	100	98	95	85	52	39	42	24	A-7-6(14)	CL
----------	100	91	70	48	13	10	----------	NP	A-4(7)	ML
----------	100	97	86	77	42	38	48	23	A-7-6(15)	CL
[5] 99	94	81	49	39	21	18	36	12	A-6(4)	SC
----------	100	98	82	70	25	20	30	9	A-4(7)	CL
----------	100	99	84	76	47	41	43	22	A-7-6(13)	CL
----------	----------	100	95	85	43	36	34	15	A-6(10)	CL

[2] Based on AASHTO Designation M 145-49 (*1*).
[3] Based on the Unified soil classification system (*2*).
[4] NP means nonplastic.
[5] 100 percent of material passed the ⅜-inch sieve.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and it has sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeabiilty, organic-matter content, and slope. If the floor needs to be leveled, depth to bedrock is important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification, and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, for example, excavations for pipelines, sewerlines, telephone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings without basements, as rated in table 6, are no more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill (trench) is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 6 apply only to a depth of about 6 feet. For this reason, limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than 6 feet. For some

soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 6, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly of asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are load-supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHTO and Unified classification of the soil material and the shrink-swell potential indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Pond embankments require soil material that is resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the factors that are unfavorable.

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence the rate of water movement; depth to the water table; slope stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by such features as slope; susceptibility to stream overflow, erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability in soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage, or depth to water table or bedrock.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope, depth to bedrock or other unfavorable material, presence of stones, permeability, and resistance to erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Engineering test data

Table 7 contains engineering test data for some of the major soil series in Kiowa County. These tests were made to help to evaluate the soils for engineering purposes. The engineering classifications shown are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Shrinkage limit is the percentage of moisture at which shrinkage of the soil material stops.

Shrinkage ratio is the relation of change in volume of the soil material to the water content of the soil material when at the shrinkage limit. The change in volume is expressed as a percentage of the air-dry volume of the soil material, and the water content is expressed as a percentage of the weight of the soil material when oven-dry.

Volume change indicates the amount of shrinking and swelling that is obtained from a sample prepared at optimum moisture content and then subjected to drying and wetting. The total change that can occur in a specified soil is the sum of the values given for shrinking and for swelling.

Tests to determine liquid limit and plasticity index measure the effect of water on the consistence of the soil material, as has been explained for table 5.

Formation and Classification of the Soils

This section describes the major factors of soil formation as they relate to the soils of Kiowa County, the processes of soil formation, and the system of classifying soils into categories broader than the series.

Factors of Soil Formation

The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil material.

Climate and vegetation are the active factors of soil formation. They act on the parent material that has accumulated through weathering and bring about the development of genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the nature of the profile and determines some of the characteristics. Finally, time is needed to change the parent material into a soil. It may be much or little, but generally much time is required to develop a profile that has distinct horizons.

The five factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made. A variation in any one of the factors results in a different kind of soil.

Parent material

Parent material is weathered, unconsolidated material in which a soil forms. In many soils it is considered to be similar to the C horizon. It affects the

color, texture, natural fertility, and other characteristics of the soil.

Soils of the uplands of Kiowa County formed in material weathered from sandstone, shale, siltstone, anorthosite, granite, limestone, and sandy, loamy, and clayey sediment. The Cobb and Dill series are examples of soils that formed in material weathered from sandstone. The Vernon and Gotebo series are examples of soils that formed in shale, clay, or siltstone. Brico soils formed in material weathered from granite. Talpa and Somervell soils formed in material weathered from limestone. The Albion series is an example of soils that formed in sandy or gravelly sediment. Meno soils formed in loamy sediment, and Mangum soils formed in clayey sediment.

Soils of the flood plains of Kiowa County formed in material weathered from loamy and sandy sediment. Clairemont, Cyril, Lugert, Port, Reinach, and Yahola soils formed in loamy alluvial sediment. Lincoln soils formed in sandy alluvial sediment.

Climate

The temperature, continental climate of Kiowa County is characterized by rains of high intensity. Moisture and warm temperatures have been sufficient to promote the formation of distinct layers in many of the soils. Differences in soils, however, cannot be attributed to climate, because the climate is uniform throughout the county.

Heavy rains can cause rapid runoff, which has eroded some of the soils. Examples of the eroded or severely eroded soils are in the Carey, Hollister, Lawton, Tillman, and Vernon series. This erosion is an indirect effect of climate.

A more complete description of the climate of Kiowa County is in the section "Climate."

Plant and animal life

Plants and animals are active in soil formation. Plants and micro-organisms grow in the weathered parent material. They help to break down rock structure and produce organic residue. As the residue is produced, an organic layer, the A1 horizon, forms.

The organic layer is the most fertile part of the soil. It is the part with which man comes in direct contact in the planting and tilling of crops. It is the layer in which bacteria, fungi, and other micro-organisms decompose organic matter, convert humus to simpler forms, liberate plant nutrients, and fix nitrogen. Larger organisms, such as earthworms, contribute to the translocation of plant residue, to aeration, and to the development of soil structure.

The kind and amount of vegetation regulate the thickness of the A1 horizon and directly affect its structure. The dominant vegetation in Kiowa County is mid and tall grasses. Grasses form a dark-colored A1 horizon, such as that in Altus, Hollister, and St. Paul soils.

Trees and tall grasses are the dominant vegetation on the flood plains in the county. Trees have had little effect on the formation of soils in this county.

Relief

Relief affects the formation of the soil through its influence on soil moisture, drainage, erosion, soil temperature, and plant cover. The relief features of Kiowa County are determined largely by the varying degrees to which the underlying material resists weathering and geologic erosion.

About 18 percent of Kiowa County consists of nearly level soils on flood plains and terraces, and 82 percent is nearly level to very steep soils on uplands and small areas of land types.

The effects of relief are evident in Hollister and Vernon soils, which formed in similar parent material but have different soil characteristics. Hollister soils are nearly level to very gently sloping and have little surface runoff; they are strongly developed. Vernon soils are very gently sloping to strongly sloping and have much surface runoff; they are weakly developed. The stronger the slope, the more rainwater runs off instead of moving through the soil and promoting the development of a deeper solum.

Time

Time, as a factor in soil formation, cannot be measured strictly in years. The length of time required for a soil to develop genetic horizons depends on the intensity and interaction of the soil-forming factors that promote losses, gains, transfers, and interactions of soil constituents, which are necessary for the formation of soil horizons. Soils that have no distinct genetic horizons are young or immature. Mature or older soils have approached equilibrium with their environment and tend to have well-defined horizons.

The soils of Kiowa County range from young to old. Some of the older soils in Kiowa County are the Hollister and Tillman soils. These soils are deeply developed and have well-expressed horizons. Clairemont and Yahola soils are on flood plains; they have been developing for a short time and show little horizon differentiation.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of soil classification have been used in the United States in recent years. The older system was adopted in 1938 (*3*) and revised later (*5*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (*4*) and adopted in 1965 (*7*).

The current system of classification has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 8, the soil series of Kiowa County are placed in three categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

SUBORDER: Each order is divided into suborders that are based mainly on those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of waterlogging, or soil differences that result from the climate or vegetation. The names of suborders have two syllables. The last indicates the order.

GREAT GROUP: Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated; those that have pans that interfere with growth of roots, movement of water, or both; and thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder.

SUBGROUP: Each great group is divided into subgroups, one that represents the central (typic) seg-

TABLE 8.—*Classification of the soil series* [1]

Series	Family	Subgroup	Order
Albion	Coarse-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Altus	Fine-loamy, mixed, thermic	Pachic Argiustolls	Mollisols.
Brico	Clayey-skeletal, mixed, thermic	Udic Argiustolls	Mollisols.
Carey	Fine-silty, mixed, thermic	Typic Argiustolls	Mollisols.
Clairemont	Fine-silty, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.
Cobb	Fine-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Cyril	Coarse-loamy, mixed, thermic	Cumulic Haplustolls	Mollisols.
Devol	Coarse-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Dill	Coarse-loamy, mixed, thermic	Udic Ustochrepts	Inceptisols.
Foard	Fine, montmorillonitic, thermic	Typic Natrustolls	Mollisols.
Gotebo	Coarse-silty, mixed, thermic	Typic Ustochrepts	Inceptisols.
Grandfield	Fine-loamy, mixed, thermic	Udic Haplustalfs	Alfisols.
Hardeman	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols.
Hinkle	Fine, montmorillonitic, thermic	Mollic Natrustalfs	Alfisols.
Hollister	Fine, mixed, thermic	Pachic Paleustolls	Mollisols.
Indiahoma	Fine, montmorillonitic, thermic	Paleustollic Chromusterts	Vertisols.
Lawton	Fine, mixed, thermic	Udic Argiustolls	Mollisols.
Lincoln	Sandy, mixed, thermic	Typic Ustifluvents	Entisols.
Lugert	Coarse-silty, mixed, thermic	Fluventic Haplustolls	Mollisols.
Mangum	Fine, mixed (calcareous), thermic	Vertic Ustifluvents	Entisols.
McLain	Fine, mixed, thermic	Pachic Argiustolls	Mollisols.
Meno	Loamy, mixed, thermic	Aquic Arenic Haplustalfs	Alfisols.
Miller	Fine, mixed, thermic	Vertic Haplustolls	Mollisols.
Natrustalfs	Not classified	Not classified	Alfisols.
Port	Fine-silty, mixed, thermic	Cumulic Haplustolls	Mollisols.
Pratt	Sandy, mixed, thermic	Psammentic Haplustalfs	Alfisols.
Reinach	Coarse-silty, mixed, thermic	Pachic Haplustolls	Mollisols.
Roscoe	Fine, montmorillonitic, thermic	Typic Pellusterts	Vertisols.
St. Paul	Fine-silty, mixed, thermic	Pachic Argiustolls	Mollisols.
Shellabarger [2]	Fine-loamy, mixed, thermic	Udic Argiustolls	Mollisols.
Somervell	Loamy-skeletal, carbonatic, thermic	Typic Calciustolls	Mollisols.
Talpa	Loamy, mixed, thermic	Lithic Calciustolls	Mollisols.
Tillman	Fine, mixed, thermic	Typic Paleustolls	Mollisols.
Tivoli	Mixed, thermic	Typic Ustipsamments	Entisols.
Tobosa	Fine, montmorillonitic, thermic	Typic Chromusterts	Vertisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols.
Yahola	Coarse-loamy, mixed (calcareous), thermic	Typic Ustifluvents	Entisols.

[1] The soil names and classification were approved in 1973.

[2] These soils are taxadjuncts to the Shellabarger series. They do not have visible secondary carbonates above a depth of 36 inches, but they are slightly effervescent between depths of 20 and 36 inches. The matrix contains fragments of fine gravel and coarse sand size and is moderately alkaline. The soils are otherwise like the Shellabarger series in morphology and are similar in use, behavior, and management.

ment of the group and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives in front of the name of the great group.

FAMILY. Soil families are established within a subgroup mainly on the basis of properties important to the growth of plants or on the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used as family differentiate.

SERIES. The series consists of a group of soils that formed in a particular kind of parent material and that have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, consistence, reaction, and mineral and chemical composition.

Climate[8]

Kiowa County has a dry-subhumid climate and is susceptible to drought. Facts about temperature and precipitation are given in table 9. Approximately 80 percent of the year's normal precipitation comes during the crop season, and a large percentage of it comes from thunderstorms, which frequently produce high-intensity rainfall. Thunderstorms occur on an average of nearly 50 days of a normal 210-day crop season in the county.

There are normally 31 days during the crop season that have rainfall of 0.10 inch or more, 23 days that have rainfall of 0.25 inch or more, 15 days that have rainfall of 0.50 inch or more, 8 days that have rainfall of 1 inch or more, and 2 days that have rainfall of 2 inches or more. Since 1902, the greatest amount of rain in a 24-hour period was 7.07 inches on May 23, 1903. It is estimated that a rainfall of 5.80 inches in 24 hours will occur an average of once every 10 years, and a rainfall of 6.65 inches in 24 hours will occur once every 25 years. It is estimated that a rainfall of 2.80 inches in 1 hour will occur an average of once every 10 years, and a rainfall of 3.45 inches in 1 hour once every 25 years. A rainfall of 1.60 inches in 15 minutes will occur an average of once every 10 years, and a rainfall of 1.97 inches in 15 minutes once every 25 years.

The normal seasonal snowfall is about 8 inches. On 4 days of an average year snowfall is 1 inch or more, and on 6 days the snow cover is 1 inch or more. Since 1910, the greatest seasonal snowfall was 20.1 inches in 1947–48. In other seasons snowfall has not been enough to measure.

Temperatures of 90°F or higher occur frequently from May to September and have been observed as early as March and as late as October. Temperature is 100° or higher about 20 days of an average year, mostly in July and August. The record high temperature at Hobart was 117° on July 19, 1936.

[8] STANLEY G. HOLBROOK, climatologist for Oklahoma, National Weather Service, U.S. Department of Commerce.

TABLE 9.—*Temperature and precipitation*

[Data from Hobart]

Month	Temperature [1]				Precipitation [2]				
	Average daily maximum	Average daily minimum	Average monthly maximum	Average monthly minimum	Average total	One year in 10 will have—		Days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
						Less than—	More than—		
	°F	°F	°F	°F	Inches	Inches	Inches	Number	Inches
January	49	25	73	7	0.8	[3]	1.8	2	2
February	54	30	76	13	1.0	0.1	2.2	2	2
March	62	35	85	17	1.3	.2	2.7	1	3
April	74	48	91	30	2.4	.5	5.0	0	0
May	81	57	96	41	5.0	1.0	10.4	0	0
June	91	67	102	55	3.6	.8	7.2	0	0
July	96	71	104	62	2.4	.4	5.2	0	0
August	95	70	105	58	1.9	.3	4.1	0	0
September	86	61	100	46	2.3	.2	5.2	0	0
October	75	50	91	33	2.5	.2	5.5	0	0
November	62	37	80	21	.9	[3]	2.3	0	0
December	52	28	72	13	1.0	[3]	2.3	1	1
Year	73	48	[4] 107	[5] 5	25.0	15.0	35.0	6	2

[1] Period of record, 1942–71.
[2] Period of record, 1941–70.
[3] Trace.
[4] Average annual highest temperature.
[5] Average annual lowest temperature.

TABLE 10.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Hobart; period of record, 1921–68]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	March 17	March 27	April 4	April 13	April 22
2 years in 10 later than	March 9	March 19	March 28	April 8	April 17
5 years in 10 later than	February 24	March 7	March 16	March 29	April 7
Fall:					
1 year in 10 earlier than	November 24	November 15	November 6	October 22	October 19
2 years in 10 earlier than	December 1	November 21	November 11	October 26	October 23
5 years in 10 earlier than	December 17	December 5	November 24	November 6	November 3

In winter there are frequent mild days and occasional spells of cold weather. Minimum temperature of 32° or less occurs on 91 days of a normal year, and on 8 days temperature will remain at or below freezing throughout the day. On only 7 days in the past 22 years has a temperature of 0° or below been recorded. The lowest temperature of record was −11° on February 13, 1905.

The average date of the last freeze in spring is April 7, and the average date of the first freeze in fall is November 3. Freezing temperatures have occurred as late as May 4 and as early as September 28. Table 10 shows the probability of freezing temperatures in the county.

The prevailing wind direction across Kiowa County is southerly, but northerly and southerly winds occur with about equal frequency from November to March. The average monthly windspeed varies from 8 miles per hour from July to November to 12 miles per hour in April. Strong gusty winds occur with thunderstorms and with low-pressure systems that migrate from west to east during winter and spring.

The average relative humidity at 6 a.m. is 75 to 85 percent throughout the year. At 6 p.m. the average relative humidity varies from about 40 percent during spring and late in summer to about 60 percent in December. An average of 160 clear days, 100 partly cloudy days, and 105 cloudy days provide residents of Kiowa County with about 70 percent of the year's total possible sunshine. Sunshine is more abundant from June to November.

Kiowa County, like all of Oklahoma, is susceptible to severe storms. They are more frequent during hot spring afternoons, but they can and have occurred in every month of the year and at every hour of the day. Hail falls on 5 days of a normal year, but not all hailstorms are so intense as to damage crops and property.

Literature Cited

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Baldwin, M., C. E. Kellogg, and J. Thorp. 1938. Soil classification. U.S. Dep. Agric. Yearb. 1938: 978-1001, illus.

(4) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027-1034.

(5) Thorp, James, and Guy D. Smith. 1949. Higher categories of soil classification: order, suborder, and great soil groups. Soil Sci. 67: 117-126.

(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplement replacing pp. 173-188 issued May 1962]

(7) ———— 1960. Soil classification, a comprehensive system, 7th approximation. Soil Conserv. Serv., 265 pp., illus. [Supplements issued March 1967, September 1968, April 1969]

Glossary

Alkali soil. Generally, a highly alkaline soil. Specifically, an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site; it reproduces itself and does not change so long as the environment does not change.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Compressible. The soil is relative soft and decreases excessively in volume when a load is applied.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressures between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is dictinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Cover crop. A close-growing crop grown primarily to improve and to protect the soil between periods of regular crop production; or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Walls of cuts are not stable. The soil sloughs easily.

Depth to rock. Bedrock is so near the surface that it affects specified use of the soil.

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

Drainage class (natural). Refers to the conditions of frequency and duration of periods of saturation or partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Drought. Soil holds too little water for plants during dry periods.

Droughty. Soil particles detach easily and cause dust.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erodes easily. Water erodes soil easily.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Excess fines. Too much silt and clay.

Excess salt. Soluble salts restrict plant growth.

Fast intake. Water infiltrates rapidly.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Floods. Soil temporarily flooded by stream overflow, runoff, or high tides.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rains. The distinction between gully and rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by normal tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage. V-shaped gullies result if the material is more difficult to erode with depth; whereas U-shaped gullies result if the lower material is more easily eroded than that above it.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Humus. The well-decomposed, more or less stable part of the organic matter in mineral soils.

Land. The total natural and cultural environment within which production takes place. Land is a broader term than soil. In addition to soil, it applies to mineral deposits and water supply; location in relation to centers of commerce and population; the size of the individual tracts of holdings; and the existing plant cover, works of improvement, and the like.

Landscape. All the characteristics that distinguish a certain kind of area on the earth's surface and give it a distinguishing pattern, in contrast to other kinds of areas. Any one kind of soil is said to have a characteristic natural landscape, and under different uses it has one or more characteristic cultural landscapes.

Large stones. Rock fragments 10 inches or more across affect the specified use.

Low strength. The soil has inadequate strength to support loads.

Leaching. The removal of soluble materials from soils or other material by percolating water.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mature soil. Any soil with well-developed soil horizons having characteristics produced by the natural processes of soil formation and in near equilibrium with its present environment.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Pan. A layer in a soil that is firmly compacted or very rich in clay. Frequently the word "pan" is combined with other words that more explicitly indicate the nature of the layers; for example, *hardpan, fragipan, claypan,* and *traffic pan.*

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Percs slowly. Water moves through the soil slowly, affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Phase, soil. A subdivision of a soil, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil series, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Piping. The soil is susceptible to the formation of tunnels or pipelike cavities by moving water.

Poorly graded. A soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles in poorly graded soil material, density can be increased only slightly by compaction.

Porosity, soil. The degree to which the soil mass is permeated with pores or cavities.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rooting depth. A layer that greatly restricts the downward rooting of plants occurs at a shallow depth.

Rotation grazing. Grazing two or more pastures, or parts of a range, in regular order, with definite recovery periods between grazing periods. Contrasts with continuous grazing.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Seepage. Water moves through the soil so quickly that it affects the specified use.

Shrink-swell. The soil expands on wetting and shrinks on drying, which may cause damage to roads, dams, building foundations, or other structures.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on relatively steep slope and in swelling clays, where there is marked change in moisture content.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Slope. Slope too great.

Slow intake. Water infiltration restricted.

Small stones. Many rock fragments less than 10 inches across.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *Very coarse sand* (2.0 to 1.0 millimeters); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.002 millimeter). The separates recognized by the International Society of Soil Science are as follows: I (2.0 to 0.2 millimeter); II (0.2 to 0.02 millimeter); III (0.02 to 0.002 millimeter); IV (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stripcropping. Growing crops in a systematic arrangement of strips, or bands, to serve as vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles) adhering together without any regular cleavage, as in many claypans and hardpans).

Stubble mulch. Stubble or other crop residues left on the soil, or partly worked into the soil, to provide protection from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Inadequate thickness of suitable soil.

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Too clayey. Soil slippery and sticky when wet and slow to dry.

Too sandy. Soil soft and loose; droughty and low in fertility.

Unstable fill. Banks of fills likely to cave or slough.

Wetness. Soil wet during period of use.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. In referring to a range site, a pasture and hay group, or a tree and shrub group, read the introduction to the section it is in for general information about its management. The capability classification system is described on pages 30 through 32. A dashed line indicates that the soil was not assigned to a particular group.

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hay group	Tree and shrub group
			Symbol	Name	Page	Number	Number
AsE	Albion-Shellabarger complex, 5 to 12 percent slopes	5	VIe-7	Sandy Prairie	39	8A	7
AtA	Altus fine sandy loam, 0 to 1 percent slopes	6	IIe-2	Sandy Prairie	39	8A	5
AtB	Altus fine sandy loam, 1 to 3 percent slopes	6	IIIe-3	Sandy Prairie	39	8A	5
BrE	Brico cobbly loam, 3 to 12 percent slopes	6	VIIs-2	Boulder Ridge	35	--	9
CaB	Carey silt loam, 1 to 3 percent slopes	7	IIe-1	Loamy Prairie	39	8A	5
CaC	Carey silt loam, 3 to 5 percent slopes	8	IIIe-2	Loamy Prairie	39	8A	5
CaC2	Carey silt loam, 2 to 5 percent slopes, eroded	8	IVe-4	Loamy Prairie	39	8A	5
CbD	Carey-Hinkle complex, 1 to 5 percent slopes	8	IVs-1	----------	--	--	--
	Carey part	--	------	Loamy Prairie	39	8A	--
	Hinkle part	--	------	Slickspot	40	8D	--
CeD3	Carey soils, 2 to 8 percent slopes, severely eroded	8	VIe-1	Eroded Prairie	36	8F	9
Cm	Clairemont and Mangum soils	9	Vw-2	----------	--	--	2
	Clairemont part	--	------	Loamy Bottomland	38	2A	--
	Mangum part	--	------	Heavy Bottomland	37	1A	--
CoB	Cobb fine sandy loam, 1 to 3 percent slopes	9	IIIe-3	Sandy Prairie	39	8A	5
Cy	Cyril loam	10	IIw-2	Loamy Bottomland	38	2A	3
DeB	Devol loamy fine sand, 0 to 3 percent slopes	10	IIIe-6	Deep Sand	35	9A	7
DrE	Dill-Rock outcrop complex, 3 to 12 percent slopes	11	VIe-3	----------	--	--	9
	Dill part	--	------	Sandy Prairie	39	8A	--
	Rock outcrop	--	------	----------	--	--	--
FdA	Foard silt loam, 0 to 1 percent slopes	11	IIs-1	Hardland	37	8D	6
GbE	Gotebo loam, 5 to 12 percent slopes	12	VIe-4	Loamy Prairie	39	8A	5
GcF	Gotebo-Rock outcrop complex, 3 to 20 percent slopes	12	VIIs-5	----------	--	--	9
	Gotebo part	--	------	Loamy Prairie	39	--	--
	Rock outcrop	--	------	----------	--	--	--
GnB	Grandfield loamy fine sand, 0 to 3 percent slopes	13	IIIe-6	Deep Sand	35	9A	5
GrB	Grandfield fine sandy loam, 1 to 3 percent slopes	13	IIIe-3	Sandy Prairie	39	8A	5
HaB	Hardeman fine sandy loam, 1 to 3 percent slopes	13	IIIe-4	Sandy Prairie	39	8A	7
HaC	Hardeman fine sandy loam, 3 to 5 percent slopes	13	IIIe-5	Sandy Prairie	39	8A	7
HaD	Hardeman fine sandy loam, 5 to 8 percent slopes	14	IVe-3	Sandy Prairie	39	8A	7
HoA	Hollister silty clay loam, 0 to 1 percent slopes	15	IIc-1	Hardland	37	8A	6
HoB	Hollister silty clay loam, 1 to 3 percent slopes	15	IIe-3	Hardland	37	8A	6
HoB2	Hollister silty clay loam, 1 to 3 percent slopes, eroded	15	IIIe-1	Hardland	37	8A	6
InB	Indiahoma silty clay loam, 1 to 3 percent slopes	16	IIIe-1	Hardland	37	7A	6
InC	Indiahoma silty clay loam, 3 to 5 percent slopes	16	IVe-1	Hardland	37	7A	6

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hay group	Tree and shrub group
			Symbol	Name	Page	Number	Number
LaB	Lawton loam, 1 to 3 percent slopes	16	IIe-1	Loamy Prairie	39	8A	6
LaC	Lawton loam, 3 to 5 percent slopes	17	IIIe-2	Loamy Prairie	39	8A	6
LaC2	Lawton loam, 2 to 5 percent slopes, eroded	17	IVe-4	Loamy Prairie	39	8A	6
LaD	Lawton loam, 5 to 8 percent slopes	17	IVe-2	Loamy Prairie	39	8A	6
LbE	Lawton-Rock outcrop complex, 1 to 12 percent slopes	17	VIe-8		--	--	--
	Lawton part	--		Loamy Prairie	39	8A	6
	Rock outcrop	--			--	--	9
Ln	Lincoln loamy fine sand	18	IVs-3	Sandy Bottomland	39	3A	4
Lo	Lincoln soils	18	Vw-1	Sandy Bottomland	39	3A	4
Lu	Lugert loam	18	IIw-2	Loamy Bottomland	38	2A	1
Mc	McLain silty clay loam	19	I-1	Heavy Bottomland	37	2A	2
MeB	Meno loamy fine sand, 0 to 3 percent slopes	20	IIe-4	Deep Sand	35	9C	5
Mr	Miller clay	20	IIIw-2	Heavy Bottomland	37	1A	2
Ms	Miller soils, saline	20	IVs-2	Alkali Bottomland	35	2C	9
Na	Natrustalfs	21	IVs-1	Slickspot	40	8D	9
Po	Port silty clay loam	21	IIw-2	Loamy Bottomland	38	2A	1
Re	Reinach loam	22	I-1	Loamy Bottomland	38	2A	1
Rk	Rock outcrop	22	VIIIs-1		--	--	--
RoF	Rock outcrop-Brico complex, 8 to 50 percent slopes	22	VIIs-3		--	--	9
	Rock outcrop	--		Hilly Stony	38	--	--
	Brico part	--		Boulder Ridge	35	--	--
Rs	Roscoe clay	23	IIIw-1	Hardland	37	7A	6
SaA	St. Paul silt loam, 0 to 1 percent slopes	24	IIc-1	Loamy Prairie	39	8A	5
SaB	St. Paul silt loam, 1 to 3 percent slopes	24	IIe-1	Loamy Prairie	39	8A	5
SbA	St. Paul-Hinkle complex, 0 to 1 percent slopes	24	IVs-1		--	--	5
	St. Paul part	--		Loamy Prairie	39	8A	--
	Hinkle part	--		Slickspot	40	8D	--
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes	25	IIIe-3	Sandy Prairie	39	8A	5
SoF	Somervell cobbly loam, 3 to 20 percent slopes	25	VIIs-1	Limestone Ridge	38	--	9
TaC	Talpa loam, 1 to 5 percent slopes	25	VIs-1	Shallow Prairie	40	14A	9
TbF	Talpa-Rock outcrop complex, 8 to 50 percent slopes	25	VIIs-6		--	--	9
	Talpa part	--		Edgerock	36	--	--
	Rock outcrop	--			--	--	--
TcB	Tillman clay loam, 1 to 3 percent slopes	26	IIe-3	Hardland	37	8A	6
TcC	Tillman clay loam, 3 to 5 percent slopes	26	IIIe-1	Hardland	37	8A	6
TdB	Tillman-Hinkle complex, 1 to 3 percent slopes	26	IVs-1		--	--	6
	Tillman part	--		Hardland	37	8A	--
	Hinkle part	--		Slickspot	40	8D	--
ToC2	Tillman-Vernon complex, 2 to 5 percent slopes, eroded	27	IVe-1		--	8A	6
	Tillman part	--		Hardland	37	--	--
	Vernon part	--		Red Clay Prairie	39	--	--
TpF	Tivoli-Pratt complex, 3 to 15 percent slopes	27	VIe-2		--	9B	8
	Tivoli part	--		Dune	36	--	--
	Pratt part	--		Deep Sand	35	--	--
TsA	Tobosa clay, 0 to 1 percent slopes	28	IIIs-2	Hardland	37	7A	6
VeC	Vernon clay loam, 2 to 5 percent slopes	28	IVe-1	Red Clay Prairie	39	8A	6

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Page	Capability unit	Range site		Pasture and hay group	Tree and shrub group
			Symbol	Name	Page	Number	Number
VmE	Vernon-Mangum complex, 0 to 12 percent slopes	28	VIe-6	----------	--	--	9
	Vernon part	--	------	Red Clay Prairie	39	8A	--
	Mangum part	--	------	Heavy Bottomland	37	1A	--
VrE	Vernon-Rock outcrop complex, 2 to 12 percent slopes	29	VIIs-4	----------	--	--	9
	Vernon part	--	------	Red Clay Prairie	39	--	--
	Rock outcrop	--	------	Eroded Red Clay	36	--	--
VsE	Vernon soils, 5 to 12 percent slopes	29	VIe-5	Red Clay Prairie	39	8A	9
Ya	Yahola fine sandy loam	29	IIw-1	Loamy Bottomland	38	2A	3

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

SOIL ASSOCIATIONS*

1 ALTUS–HARDEMAN–SHELLABARGER association: Nearly level to strongly sloping, deep, well drained soils that are loamy throughout; on uplands.

2 HOLLISTER–TILLMAN–LAWTON association: Nearly level to sloping, deep, well drained loamy soils that have a loamy to clayey subsoil; on uplands.

3 ST. PAUL–CAREY association: Nearly level to sloping, deep, well drained soils that are loamy throughout; on uplands.

4 ROCK OUTCROP–BRICO–TALPA association: Very gently sloping to very steep Rock outcrop and very gently sloping to moderately steep, very shallow, shallow, or deep, well drained loamy soils that have a loamy to clayey subsoil; on uplands.

5 VERNON association: Very gently sloping to strongly sloping, moderately deep, well drained loamy to clayey soils that have a clayey subsoil; on uplands.

6 PORT–LUGERT–CLAIREMONT association: Nearly level, deep, well drained soils that are loamy throughout; on flood plains.

7 MILLER association: Nearly level, deep, moderately well drained soils that are loamy or clayey throughout; on flood plains.

* The terms for texture used in the titles of the association apply to the surface layer unless otherwise indicated.

Compiled 1977

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
OKLAHOMA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

KIOWA COUNTY, OKLAHOMA

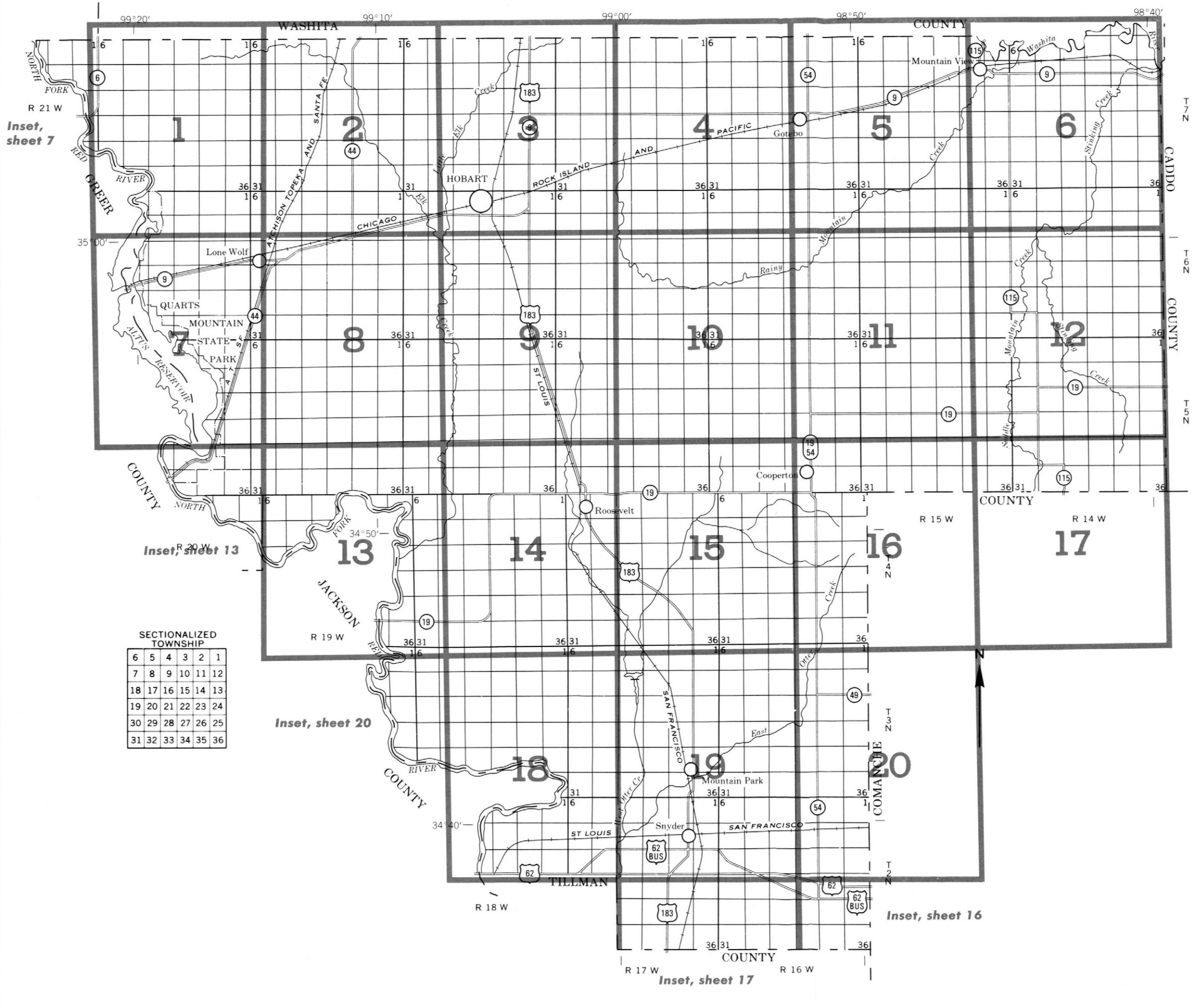
Scale 1:253,440

1 0 1 2 3 4 Miles

INDEX TO MAP SHEETS
KIOWA COUNTY, OKLAHOMA

Scale 1:253,440

1 0 1 2 3 4 Miles



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

The first letter, a capital, is the initial one of the soil name. The second position is used to identify additional mapping units that have the same initial capital letter. The third position, if used, is a capital letter and connotes slope class. Symbols without a slope letter are for nearly level soils, or land types. A final number, 2 or 3 in the symbol, shows the soil is eroded, or severely eroded, respectively.

SYMBOL	NAME
AsE	Albion-Shellabarger complex, 5 to 12 percent slopes
AtA	Altus fine sandy loam, 0 to 1 percent slopes
AtB	Altus fine sandy loam, 1 to 3 percent slopes
BrE	Brico cobbly loam, 3 to 12 percent slopes
CaB	Carey silt loam, 1 to 3 percent slopes
CaC	Carey silt loam, 3 to 5 percent slopes
CaC2	Carey silt loam, 2 to 5 percent slopes, eroded
CbD	Carey-Hinkle complex, 1 to 5 percent slopes
CeD3	Carey soils, 2 to 8 percent slopes, severely eroded
Cm	Clairemont and Mangum soils
CoB	Cobb fine sandy loam, 1 to 3 percent slopes
Cy	Cyril loam
DeB	Devol loamy fine sand, 0 to 3 percent slopes
DrE	Dill-Rock outcrop complex, 3 to 12 percent slopes
FdA	Foard silt loam, 0 to 1 percent slopes
GbE	Gotebo loam, 5 to 12 percent slopes
GcF	Gotebo-Rock outcrop complex, 3 to 20 percent slopes
GnB	Grandfield loamy fine sand, 0 to 3 percent slopes
GrB	Grandfield fine sandy loam, 1 to 3 percent slopes
HaB	Hardeman fine sandy loam, 1 to 3 percent slopes
HaC	Hardeman fine sandy loam, 3 to 5 percent slopes
HaD	Hardeman fine sandy loam, 5 to 8 percent slopes
HoA	Hollister silty clay loam, 0 to 1 percent slopes
HoB	Hollister silty clay loam, 1 to 3 percent slopes
HoB2	Hollister silty clay loam, 1 to 3 percent slopes, eroded
InB	Indiahoma silty clay loam, 1 to 3 percent slopes
InC	Indiahoma silty clay loam, 3 to 5 percent slopes
LaB	Lawton loam, 1 to 3 percent slopes
LaC	Lawton loam, 3 to 5 percent slopes
LaC2	Lawton loam, 2 to 5 percent slopes, eroded
LaD	Lawton loam, 5 to 8 percent slopes
LbE	Lawton-Rock outcrop complex, 1 to 12 percent slopes
Ln	Lincoln loamy fine sand
Lo	Lincoln soils
Lu	Lugert loam
Mc	McLain silty clay loam
MeB	Meno loamy fine sand, 0 to 3 percent slopes
Mr	Miller clay
Ms	Miller soils, saline
Na	Natrustalfs
Po	Port silty clay loam
Re	Reinach loam
Rk	Rock outcrop
RoF	Rock outcrop-Brico complex, 8 to 50 percent slopes
Rs	Roscoe clay
SaA	St. Paul silt loam, 0 to 1 percent slopes
SaB	St. Paul silt loam, 1 to 3 percent slopes
SbA	St. Paul-Hinkle complex, 0 to 1 percent slopes
ShC	Shellabarger fine sandy loam, 3 to 5 percent slopes
SoF	Somervell cobbly loam, 3 to 20 percent slopes
TaC	Talpa loam, 1 to 5 percent slopes
TbF	Talpa-Rock outcrop complex, 8 to 50 percent slopes
TcB	Tillman clay loam, 1 to 3 percent slopes
TcC	Tillman clay loam, 3 to 5 percent slopes
TdB	Tillman-Hinkle complex, 1 to 3 percent slopes
ToC2	Tillman-Vernon complex, 2 to 5 percent slopes, eroded
TpF	Tivoli-Pratt complex, 3 to 15 percent slopes
TsA	Tobosa clay, 0 to 1 percent slopes
VeC	Vernon clay loam, 2 to 5 percent slopes
VmE	Vernon-Mangum complex, 0 to 12 percent slopes
VrE	Vernon-Rock outcrop complex, 2 to 12 percent slopes
VsE	Vernon soils, 5 to 12 percent slopes
Ya	Yahola fine sandy loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small (water; w)

PITS

- Gravel pit
- Mine or quarry (small)

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (CeA; FoB2)

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

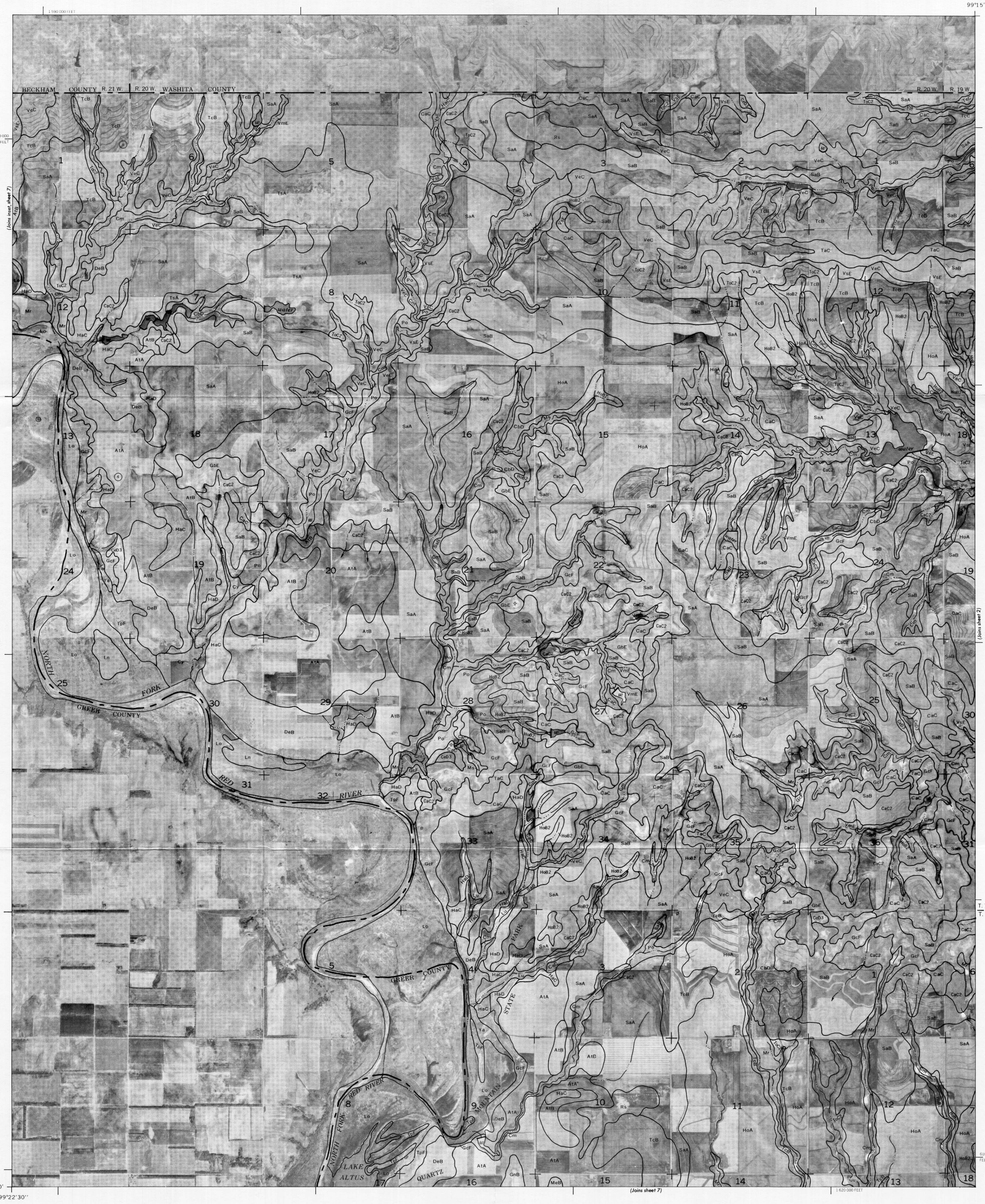
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown)

MISCELLANEOUS

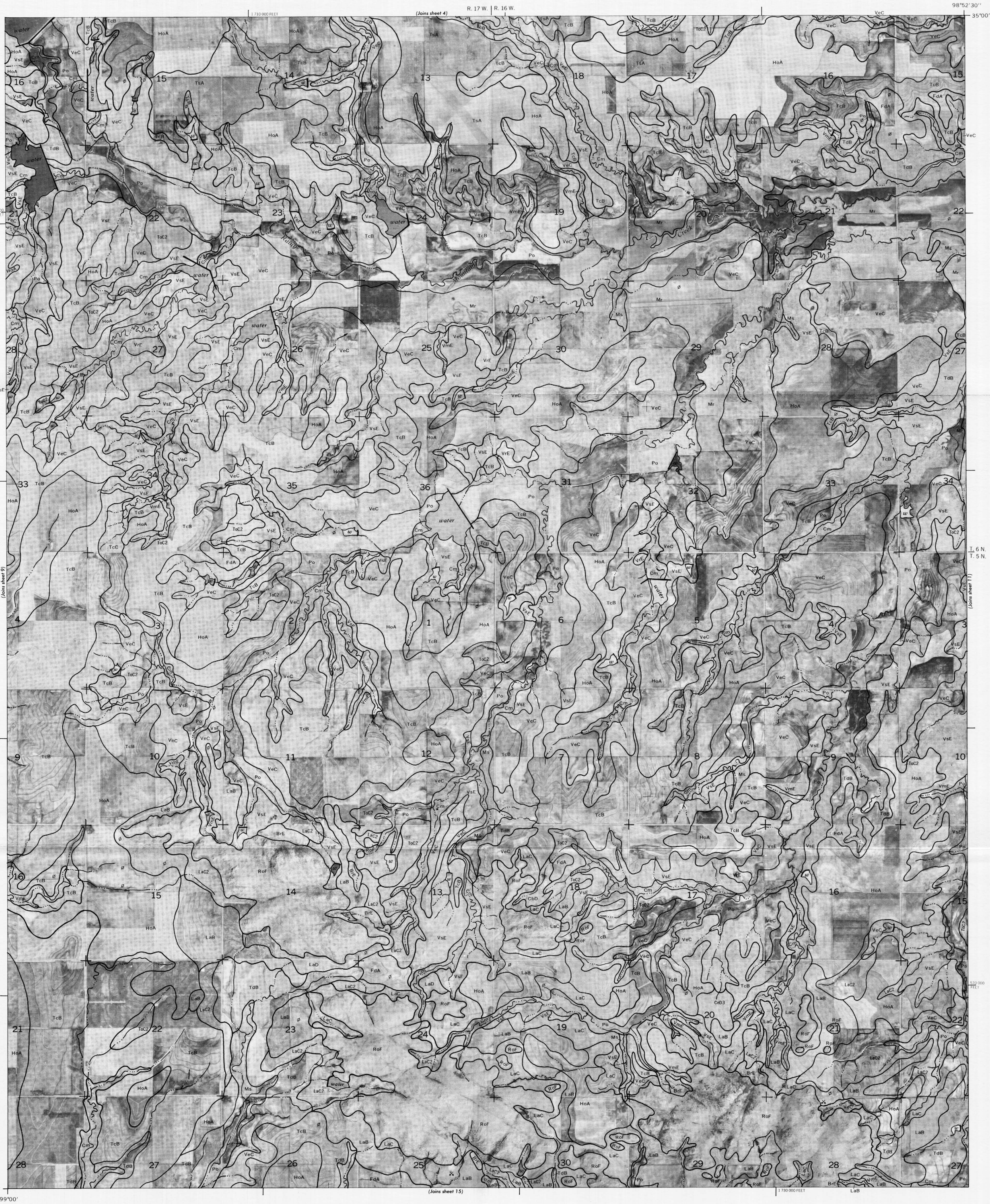
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot



This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 1



This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 10

1 740 000 FEET

R. 16 W. | R. 15 W.

(Joins sheet 5)

98°45′

35°00′

600 000 FEET

RAINY MOUNTAIN INDIAN SCHOOL RESERVATION

Rainy Mountain Creek

Unap Mountain

LIMESTONE QUARRY

Sugar Creek

Longhorn Creek

T. 6 N.
T. 5 N.

(Joins sheet 10)

(Joins sheet 12)

570 000 FEET

34°52′30″

98°52′30″

(Joins sheet 16)

1 770 000 FEET

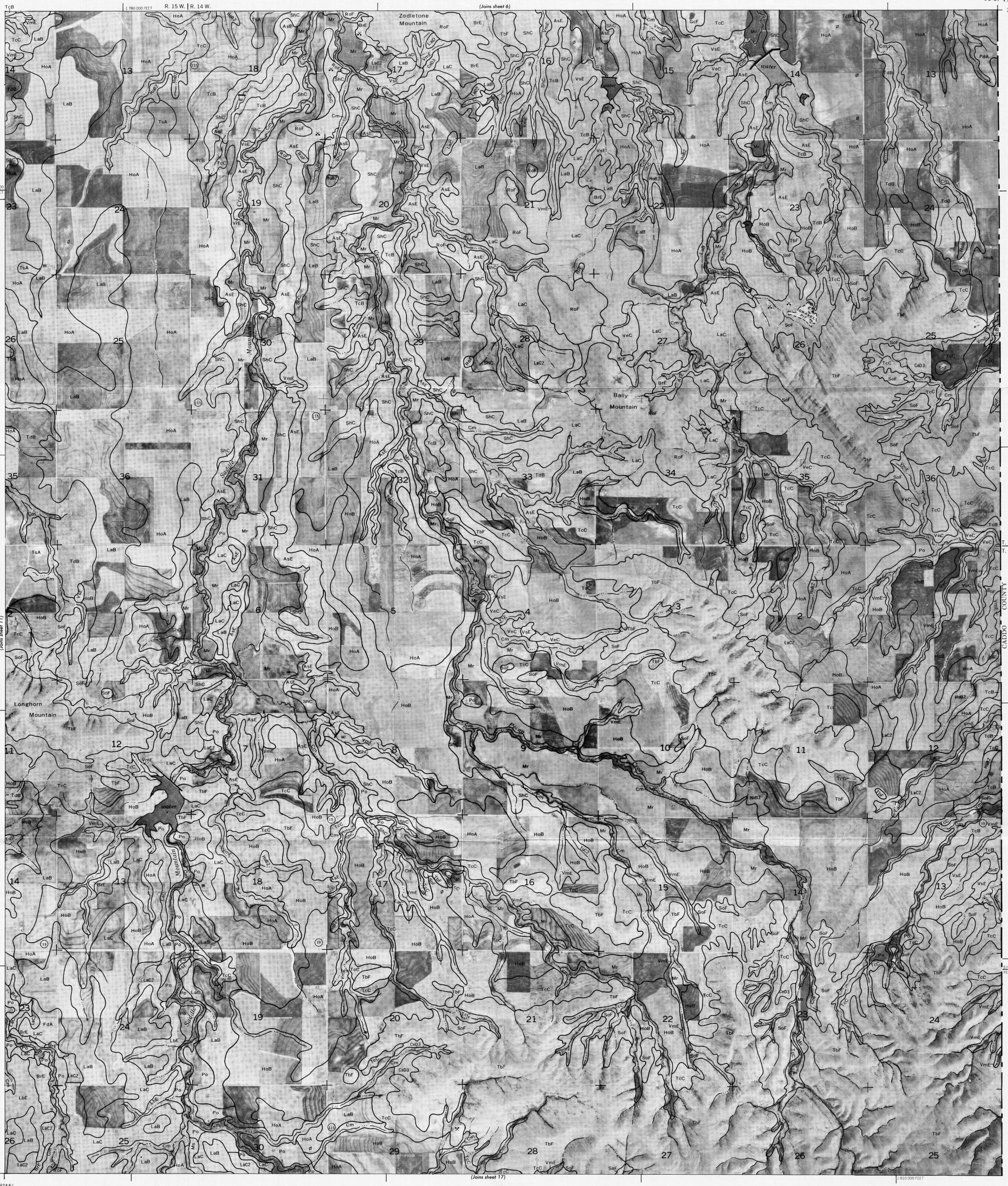
This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24 000

KIOWA COUNTY, OKLAHOMA NO. 11



This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

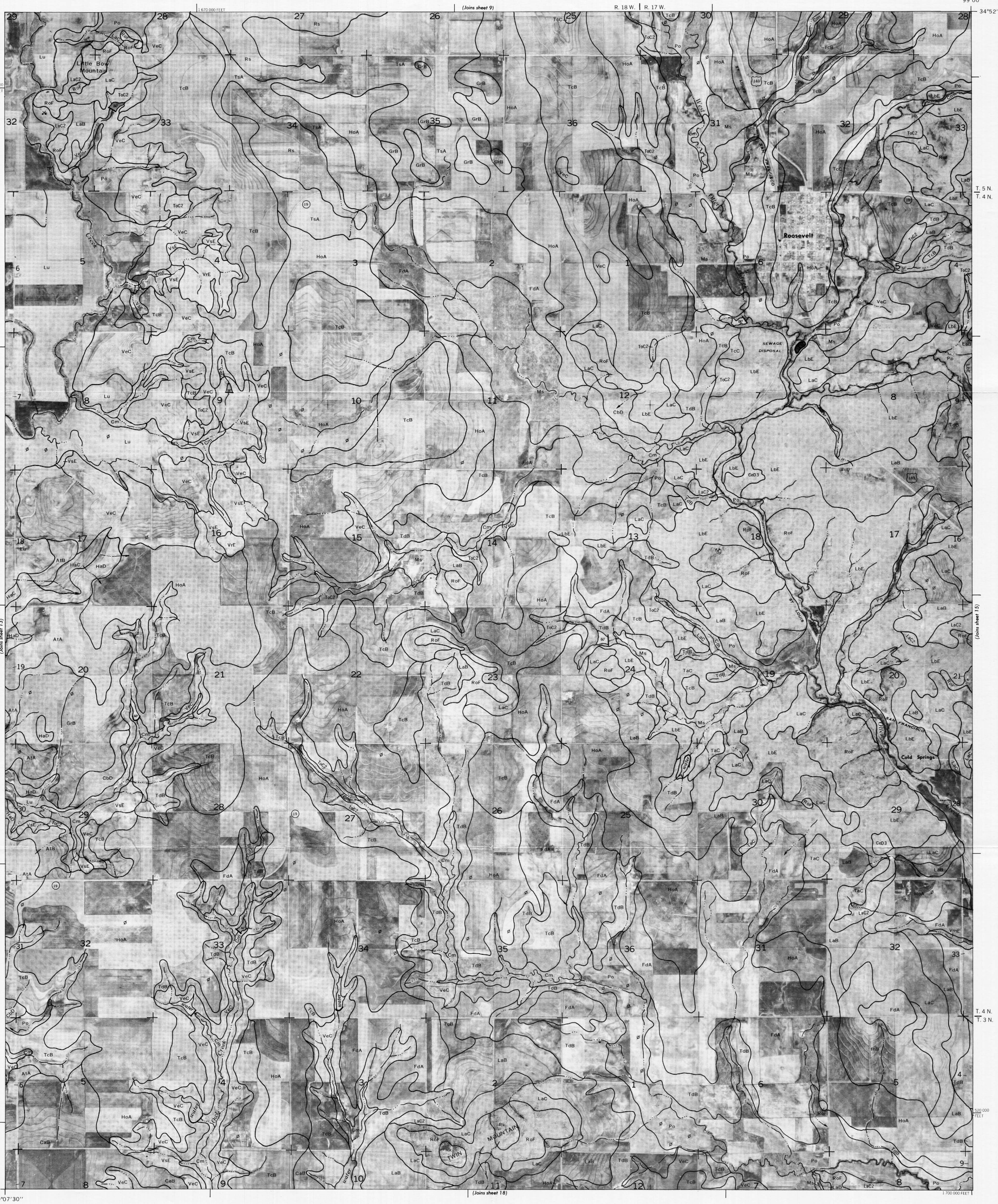
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 12

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 13



This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

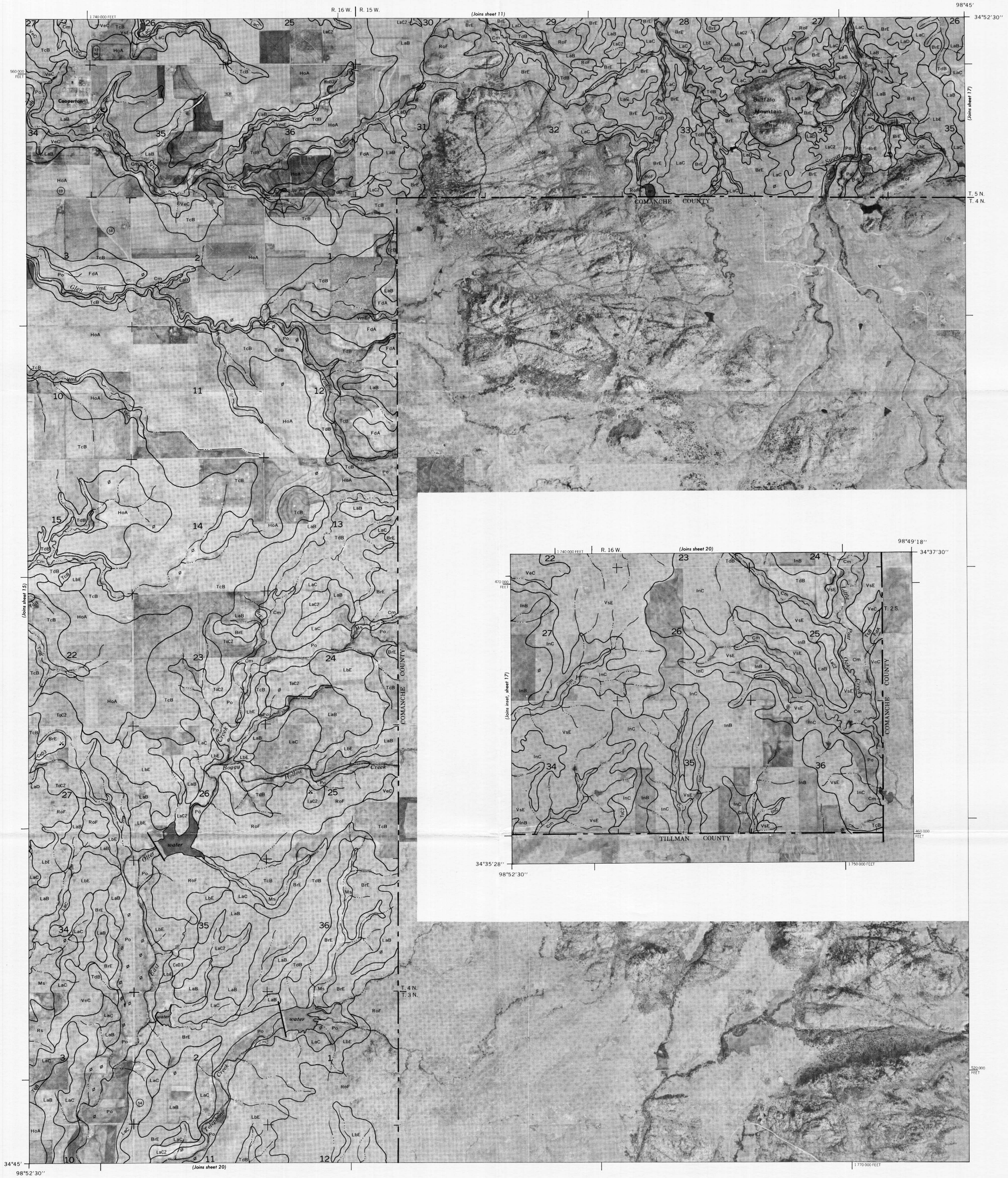
1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 14

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 15



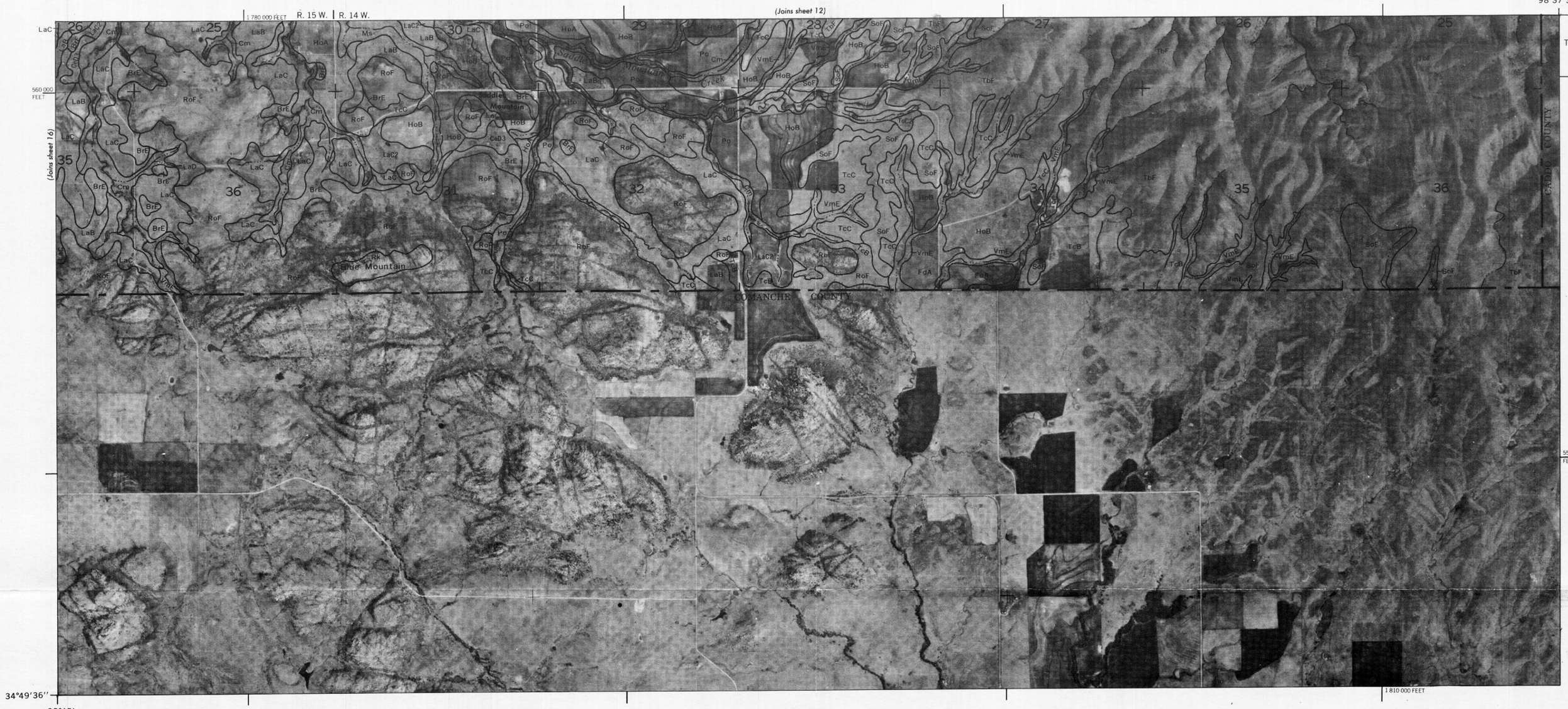
This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

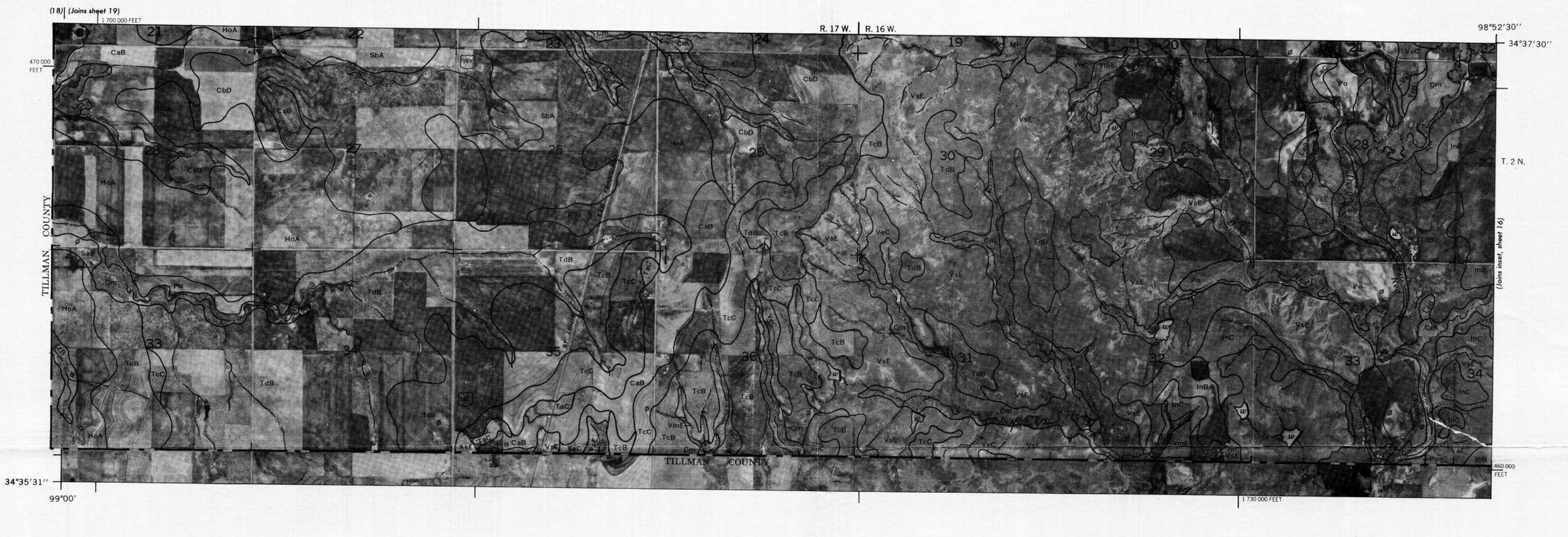
1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

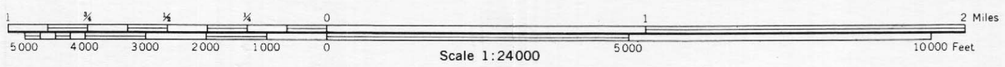
KIOWA COUNTY, OKLAHOMA NO. 16

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 17
KIOWA COUNTY, OKLAHOMA







This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

KIOWA COUNTY, OKLAHOMA NO. 17

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

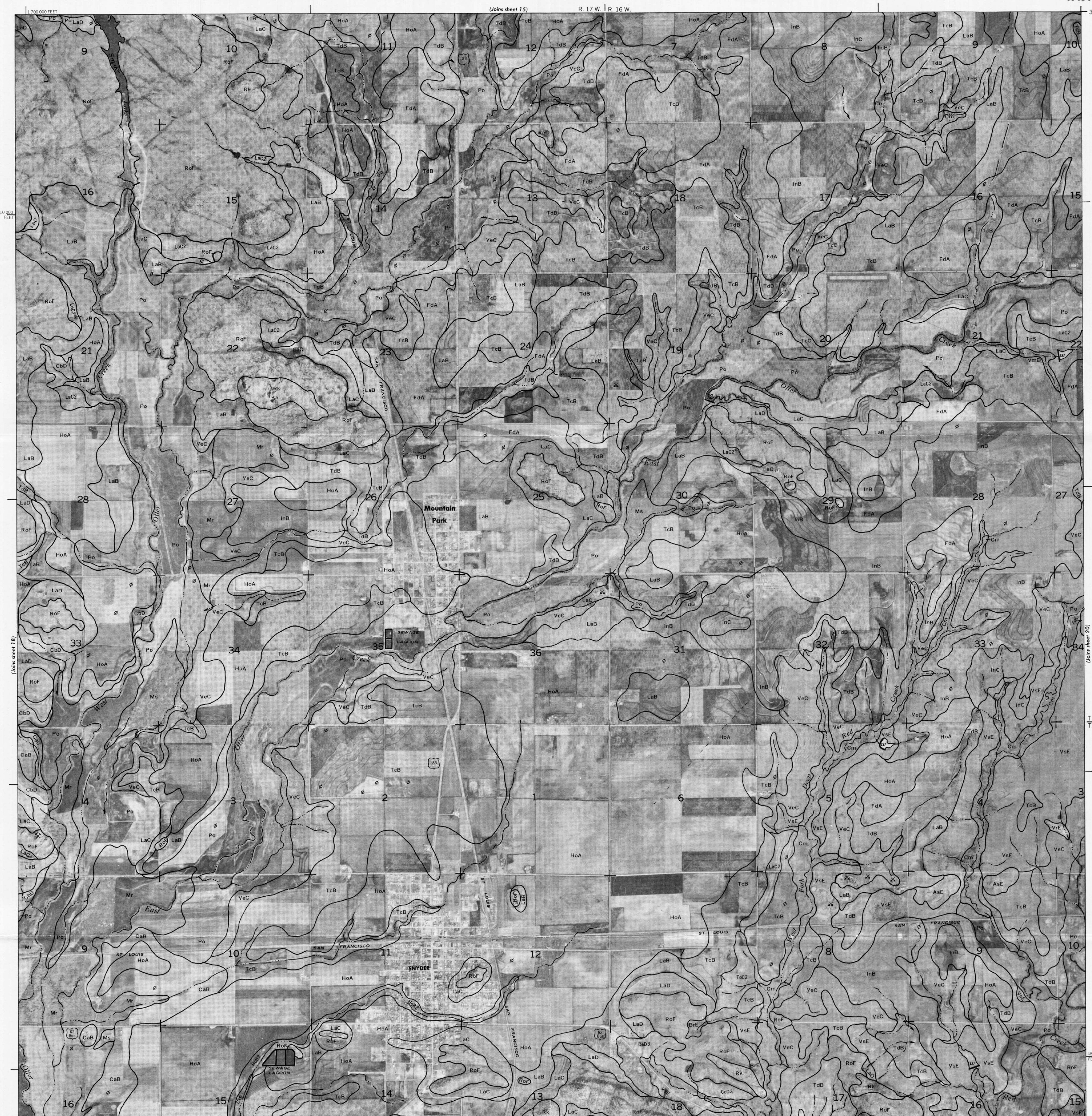
SHEET NO. 18
KIOWA COUNTY, OKLAHOMA

99°00′
34°45′
R. 18 W. | R. 17 W.
1 670 000 FEET
(Joins sheet 14)
510 000 FEET
(Joins inset sheet 20)
(Joins sheet 19)
T. 3 N.
T. 2 N.
480 000 FEET
1 690 000 FEET
34°37′30″
99°07′30″
JACKSON COUNTY
TILLMAN COUNTY
RED RIVER
NORTH FORK
SAN FRANCISCO ST LOUIS
Dempsey Peak
LONG MOUNTAIN
Owl Creek
water
Tanks

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 18



Scale 1:24000

1 ¾ ½ ¼ 0 1 2 Miles

5000 4000 3000 2000 1000 0 5000 10000 Feet

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

99°07'30"
35°07'30"
1 630 000 FEET
650 000 FEET

WASHITA COUNTY
R. 19 W.
R. 18 W.

Elk Creek
SANTA FE
ATCHISON TOPEKA AND SANTA FE
PACIFIC
ROCK ISLAND
CHICAGO

(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 8)

T. 7 N.
T. 6 N.

610 000 FEET
1 650 000 FEET

35°00'
99°15'

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 2

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
Scale 1:24 000

KIOWA COUNTY, OKLAHOMA NO. 20

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 3
KIOWA COUNTY, OKLAHOMA

1 670 000 FEET

99°00′

35°07′30″

650 000 FEET

WASHITA COUNTY

R. 18 W. | R. 17 W.

T. 7 N.
T. 6 N.

(Joins sheet 2)

(Joins sheet 4)

HOBART
(county seat)

Hunter Lake

Elk Creek

Little Elk Creek

Saddler

Little Saddler

SAN FRANCISCO

ST. LOUIS

GRAVEL RD.

PACIFIC AND ROCK ISLAND CHICAGO

(Joins sheet 9)

610 000 FEET

1 700 000 FEET

35°00′

99°07′30″

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 3

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 4

1 740 000 FEET

98°45′

35°07′30″

650 000 FEET

R. 16 W. | R. 15 W.

WASHITA COUNTY

Gotebo

MOUNTAIN VIEW

PACIFIC AND ROCK ISLAND CHICAGO

Mountain Creek

Rainy Mountain Creek

Sugar Creek

water

(Joins sheet 4)

(Joins sheet 6)

T 7 N.
T. 6 N.

610 000 FEET

35°00′

98°52′30″

(Joins sheet 11)

1 770 000 FEET

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet

Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 5

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 6
KIOWA COUNTY, OKLAHOMA

1 780 000 FEET

R. 15 W. | R. 14 W.

98°37'30"

35°07'30"

650 000 FEET

T 8 N.
T 7 N.

WASHITA RIVER

WASHITA COUNTY

CADDO COUNTY

(Joins sheet 5)

(Joins sheet 12)

T. 7 N.
T. 6 N.

610 000 FEET

1 810 000 FEET

35°00'

98°45'

MOUNTAIN VIEW

SEWAGE LAGOON

ROCK ISLAND AND PACIFIC

CHICAGO

Mountain Creek

Rainy Mountain Creek

Saddle Mountain

Zodletone Mountain

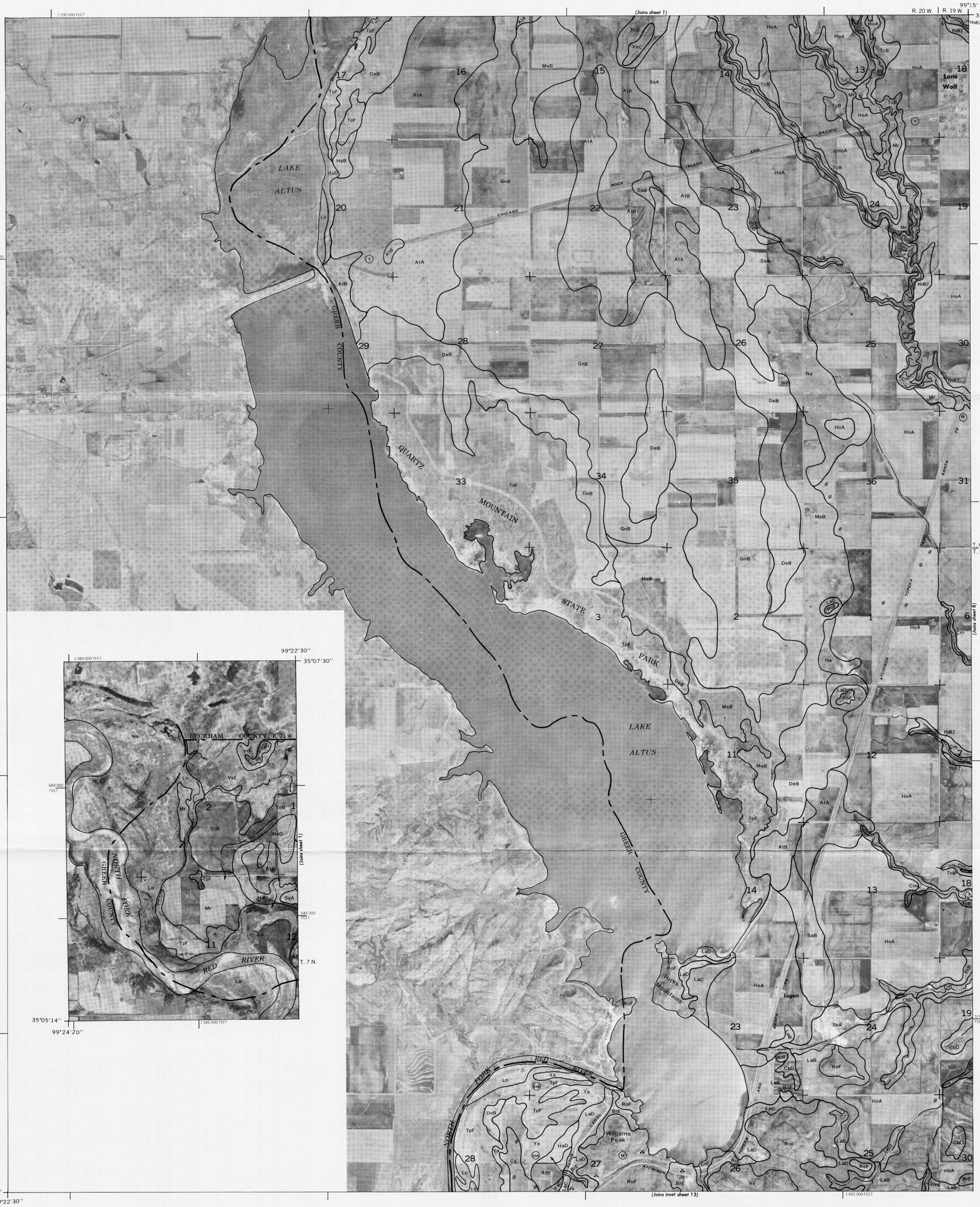
Sinking Creek

water

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10 000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 6



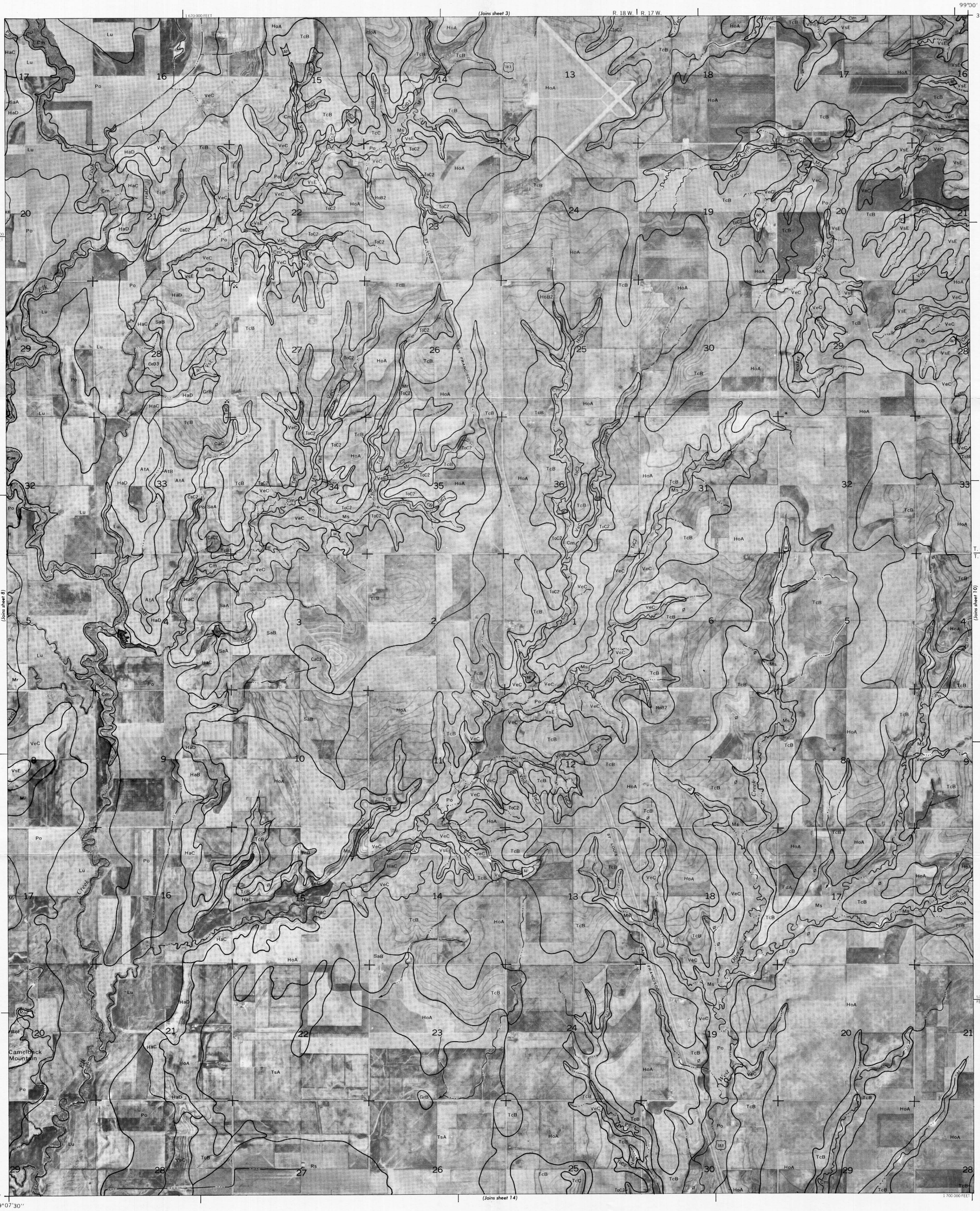
This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 10 000 Feet
Scale 1:24000

KIOWA COUNTY, OKLAHOMA NO. 7

This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

KIOWA COUNTY, OKLAHOMA NO. 8



This map was compiled by U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies on 1975 orthophotography obtained from U.S. Department of the Interior, Geological Survey.

1 ¾ ½ ¼ 0 1 2 Miles
5000 4000 3000 2000 1000 0 5000 10000 Feet
Scale 1:24000

KIOWA CUNTY, OKLAHOMA NO. 9